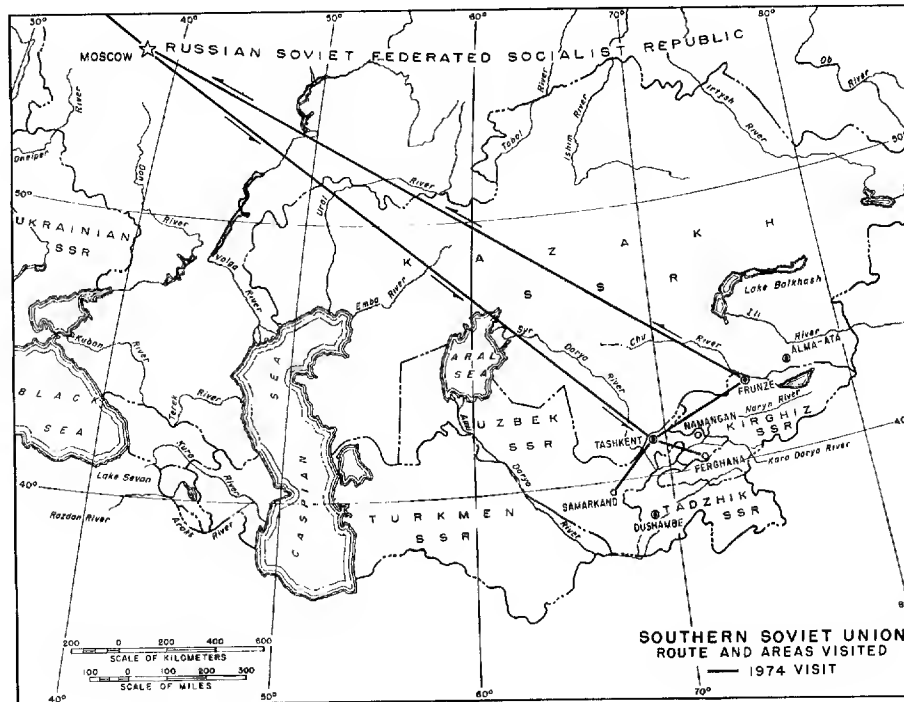


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AUTOMATION AND REMOTE CONTROL IN WATER RESOURCE SYSTEMS

Report of the United States Delegation Visit to the Union of Soviet Socialist Republics September 14-28, 1974



Visit Arranged in Accordance with U.S.-U.S.S.R. Joint Commission
on Scientific and Technical Cooperation

December 1974

State Dept. declassification & release instructions on file

Approved For Release 2002/03/28 : CIA-RDP79-00798A000600100008-3

CIA WATER RESOURCES

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AUTHORIZATION/INTRODUCTION

The U.S./U.S.S.R. Joint Commission on Scientific and Technical Cooperation came into existence as a result of the detente agreements reached between the two countries in 1972. One of the areas of cooperation identified was the field of water resources. Likewise one of the four problem areas in water resources that was selected for joint effort is the subject of this report, namely Project III.2 - "Methods and Means of Automation and Remote Control in Water Resource Systems."

Active pursuit of this project started in 1973 and early 1974 with an exchange of correspondence and technical literature. A four-man Soviet delegation visited the United States from June 16-28, 1974, and toured automated water resource systems through the Western United States. At the conclusion of this visit an agreement was reached to consider a 6-year joint program of research and development of automated water systems in each country. The four-man U.S. delegation then visited automated water systems in the U.S.S.R. during the period September 14-28, 1974. At the end of this visit an agreement was reached on the joint activities for the next 2 years.

The program of cooperation that was agreed upon consists of the selection of an "experimental project" in each country. The Soviets chose a canal system in the Chu River Basin near Frunze, Kirghizia, described in Appendix B and the United States chose the Corning Canal in California. Each country will prepare a report, or series of reports, on their own projects, describing the projects, the alternatives considered for automation, and the automation system finally selected. These reports will be exchanged, and there will be a technical exchange in person in the fall of 1975 involving a 2-week trip to each country to review progress.

The emphasis in the present agreement is on automation of main canals and large turnouts. Both countries recognize the need for the automation to extend "up" to the river system and "down" to laterals and onfarm systems. The more complete approach (from snowfield to farm sprinkler) perhaps would be theoretically preferable, but at present it appears more practical to take the more limited and more manageable step of concentrating first on main canals and turnouts.

On the basis of the exchange of visits in 1974, it appears the prospects are favorable for mutual benefits to be obtained by both the United States and the U.S.S.R. on the exchange of automation technology. Another, but important, benefit of the exchange has been the personal friendships that have been formed between the United States and the U.S.S.R. team members.

This report is intended to document the visit of the U.S. delegation to the U.S.S.R. in September 1974. The contents are presented in chronological order with descriptions of locations and institutes visited. The appendices include:

- A. Record of Meeting
- B. Description of U.S.S.R. Experimental Project
- C. Delegation membership and Soviet hosts

While best efforts to obtain accurate data were made by Soviet engineers, the interpreters, and the Delegation, it should be recognized that the information reported herein may contain errors. The vast areas of interest and geographical locations involved, and the press of time at each location, made it difficult to verify or coordinate all information received. Additional insight and general background on "Irrigation in the U.S.S.R." can be gained from the 1963 and the 1972 U.S. Team Reports.

E. F. Sullivan
U.S. Project Coordinator

ITINERARY

Itinerary of the Visit to the U.S.S.R.
by the U.S. Team under
Project III.2, "Methods and Means of Automation and
Remote Control of Water Resource Systems"

September 12	Briefing in USBR Commissioner's Office Washington, D.C.
September 13-14	Travel to Moscow
September 15	Arrange itinerary and transportation in Soviet Union Moscow sightseeing
September 16	Visit to the USSR Exhibition of Economic Achieve- ments (the pavilion "Reclamation and Water Management in the USSR"). Confer with experts from the BNIIMiTP Institute Visit to the design center of water resource projects (V/O SOJUZVODPROJECT) Leave for Tashkent
September 17	Arrive Tashkent in the morning Confer with officials at the Uzbek SSR Ministry for Reclamation and Water Management Visit to the SANIIRI Institute Tashkent sightseeing
September 18	Depart for Ferghana Visit to the Ferghana Canal Trip by automobile to the headworks Visit projects furnished with automatic and remote control devices Return to Tashkent
September 19	Visit water projects in the Golodnaya Steppe Arrive Samarkand
September 20	Samarkand sightseeing Visit to Ak-Karadarinsk hydroelectric complex
September 21	Depart Samarkand Arrive Frunze

September 22	Frunze sightseeing Visit to the All-Union Research Institute of Water Resource System Integrated Automation (VNI IKAMS) Explanation of Institute
September 23	Visit to the joint pilot project site Discussion of subjects related to research programs
September 24	Discussion of the comprehensive program of the second-stage activities for 1976 and of the joint pilot project
September 25	Finalize the program of activities under project "Methods and Means of Automation and Remote Control of Water Resource Systems" for 1976 and of the protocol on the stay of the U.S. delegation in the U.S.S.R.
September 26	Leave for and arrive Moscow
September 27	Visit to U.S. Embassy, Moscow Clearance of Record of Meeting Signing of Record of Meeting
September 28	Depart Moscow for Paris
September 29	Return to United States

MOSCOW

Ministry of Reclamation and Water Management (MRWM)

MRWM is the main water resource agency in the U.S.S.R. Its mission is somewhat equivalent to that of the Bureau of Reclamation's in the Western United States; however, it is much larger in size and budget. Because of its size and importance this Ministry is comparable to a full department in the U.S. Government.

Irrigation is considered vitally important to insure adequate food and fiber for the Soviet nation and to assure wise use of the nation's natural resources. Shortly after the formation of the Soviet Union, V. I. Lenin documented the importance of assuring successful harvests with irrigation and land reclamation. The Lenin document is given great significance by the Soviet government and portions of it can be seen prominently displayed at many water resource control centers.

The following quotes from an article in the Moscow News, September 21, 1974, by Boris Shtepa, U.S.S.R., Deputy Minister of Reclamation and Water Management, demonstrates the U.S.S.R. water resource situation and the eminent role of the Ministry as viewed by the Soviets.

"The Soviet Union has the largest water resources in the world. The average Soviet river discharge is over 4,700 cu km (3,820,000,000 acre feet), and the annual water consumption for household and industrial use is nearly 300 cu km (244,000,000 acre-feet). So one would hardly expect to find any water supply problem. But the resources are not evenly distributed--the better developed areas, which have 85 per cent of the population and produce some 80 per cent of industrial and agricultural output, have only 20 per cent of the total water resources.

"The Soviet state, which abolished private ownership of natural resources right from the start, has paid a lot of attention to the rational use of water. The regulation of water is codified in the Fundamentals of Water Legislation of the USSR and the Union Republics. Water conservation is an inseparable part of the economic management of water. There is a master plan for an integrated use and conservation of water resources and patterns for individual large basins, regions and administrative districts.

"The responsibility for rational use and for protecting water resources against pollution, contamination, and depletion is vested in the * * * MRWM * * *. Daily state supervision is exercised by 102 Basin Inspectors, which keep an eye on approximately 85,000 projects.

Information in parenthesis added by author of report

"The Soviet water economy is many-faceted and includes water supplies, agricultural hydroengineering systems, internal waterways, logging, fisheries, and hydroelectric power. * * *.

"New canals built in Soviet years include the Moskva Canal linking the Moskva River (fig. 1) with the Volga, and the White Sea-Baltic, the Volga-Don, the Volga-Baltic, and other canals. They have added 18,000 km (11,200 miles) to our navigable waterways. Many of these canals have helped solve the problem of water supply and irrigation.



Figure 1. Moskva River viewed from Hotel Rossia, Moscow

"Water supply has been improved in many parts of the country--3,700 km (2,300 miles) of canals were built to redistribute 40 cu km (33,000,000 acre feet) of river water. More than 1,000 reservoirs were built-- 17 per cent of the world's reservoirs. The dam of the Bratsk Hydroelectric Power Station on the Angara River in East Siberia has formed a reservoir of 169 cu km (137,000,000 acre feet), the largest in the world.

"All this has already been accomplished. Now a mammoth plan is in the offing--to divert part of the northern rivers' discharge to the Caspian Sea basin, and a part of the Siberian rivers' discharge to

the Aral Sea basin, to Central Asia and Kazakhstan. These projects are being developed.

"Deserts Became Plantations

"About 57 per cent of the water consumed in the USSR is used for irrigating 12.5 million hectares (31 million acres) of land. Last year alone saw about a million hectares of new irrigation, to say nothing of more than 900,000 hectares (2,200,000 acres) of drainage. Work is nearing completion on reclaiming salt land in the Hungry Steppe in the Uzbek SSR--more than 300,000 hectares (740,000 acres). Today the Hungry Steppe is hungry no longer. It is a land of vast cotton plantations, modern well-appointed state-farm communities, crisscrossed by highways, water mains, and overhead transmission lines.

"Only three per cent of all farmland in the country is reclaimed, yet it yields 25 per cent of the total agricultural produce. Some 7.66 million tons--a record cotton crop--was taken in 1973.

"The total area in need of irrigation in the USSR is estimated at 120 million hectares (300 million acres). Irrigating them means a tenfold increase in water consumption. This means that more rational use of water is required. Seepage control, canal troughs, pipelines, modern patterns of watering, automatically controlled irrigation systems--all help greatly reduce water consumption and lessen the danger of salinization and bogging."

MRWM is responsible for Water Resource development and management. As such it recognizes the importance of automation of water resource systems. The ministry's support of the joint U.S./U.S.S.R. Water Resource Program also includes involvement in two of the other three joint projects, namely, "Planning, Utilization and Management of Water Resources" and "Use of Plastics in Construction." The project "Cold Weather Construction" is handled by the Ministry of Hydro-Power.

MOSCOW
SOJUZVODPROJECT

The following functional description was provided at a briefing by Director A. M. Volynov on September 16, 1974:

This All-Union Institute is responsible for the planning, design, and construction inspection of reclamation projects throughout the Soviet Union. While this Institute is analogous to the Bureau of Reclamation's Engineering and Research Center, it encompasses more

activities. Included in the Institute are the headquarters office in Moscow and 55 design institutes located throughout the U.S.S.R. These can be divided into (1) Institutes engaged in investigations and research; and (2) Institutes that prepare final plans and specifications for projects. Construction is performed by another organization but is inspected by SOJUZVODPROJECT. After a 3-year testing period, the project is assigned to another organization for operation and maintenance.

About one-half of the work of the 55 institutes is done under assignment from MRWM and the rest of the work from various Soviet republics and individual collective or state farms or other organizations is handled by "contract."

The cost of operating the Institutes amounts to 300,000,000 rubles per year (\$400,000,000) and the construction program is 6,000,000,000 rubles (\$8,000,000,000) per year. Before comparisons are made with the U.S.A., it must be noted this includes not only the design of main canals and laterals, but also distribution to the collective and state farms which range from 800 hectares (2,000 acres) to over 8,000 hectares (20,000 acres) in size. Also included are all associated activities such as villages, roads, and so forth. A ruble converted to man-hours of work may not be the same as in the U.S.A. since wages and other economic values are not necessarily comparable. The area of land to be drained and irrigated is an impressive 13,000,000 hectares (32,000,000 acres) in the current 5-year plan. Official exchange rate at the time of our visit was 1 ruble = \$1.33.

The following explanation of an automated irrigation system on the Volga River was presented in our briefing:

Two hundred thousand hectares (500,000 acres) are to be irrigated. The project is now about one-third complete and is to be fully automated with controls operating on electrically and hydraulically powered systems. The entire project area is to be irrigated by sprinkler systems having a total power requirement of 300,000 kw. Main pumps for the sprinkler distribution system supply about 1,000 hectares (2,500 acres) each. These pumps are served by main canals and subcanals. The capacity at the headworks is 60 cubic meters per second (2,200 ft³/s) and water must be pumped from the Volga River. Many reservoirs on the system help regulate the supply to the land. This can be characterized as partially a demand system and rotation system. Demand will be met within the capabilities of the system. One interesting aspect is that even though power use is high, they did not design for and do not have

to operate to meet onpeak/offpeak conditions on power supply. The power system is managed by the Ministry of Electrification. No question has been raised about power peaking problems. Based on these brief discussions, we concluded the Soviets have found it is less expensive to provide peaking on the power system than to try to operate the water system offpeak as much as possible (as we do in the U.S.A.). This may be valid now, but in the future power needs will probably grow faster than water pumping needs and more and more power will be supplied by oil and coal. This may eventually lead to the condition that we have in the U.S.A. where it is important to reduce onpeak pumping by providing as much offpeak pumping for irrigation and drainage as possible.

MOSCOW
BNIIMiTP

We met with members of this institute at the U.S.S.R. Exhibition of Economic Achievements in the pavillion "Reclamation and Water Management in the U.S.S.R." This institute is concerned with the mechanization of irrigation. Our discussions indicated a great deal of interest in sprinkler irrigation and we were supplied literature on the various sprinkler methods used in the U.S.S.R. however, automation was treated as a peripheral activity of this institute. The Soviets continue to use sprinkler methods such as large boom sprinklers mounted on crawler tractors (fig. 2) and "big gun" sprinklers (fig. 3) which also are mounted on crawler tractors. Both of these methods required a full-time operator and a closely spaced ditch system for water supply.

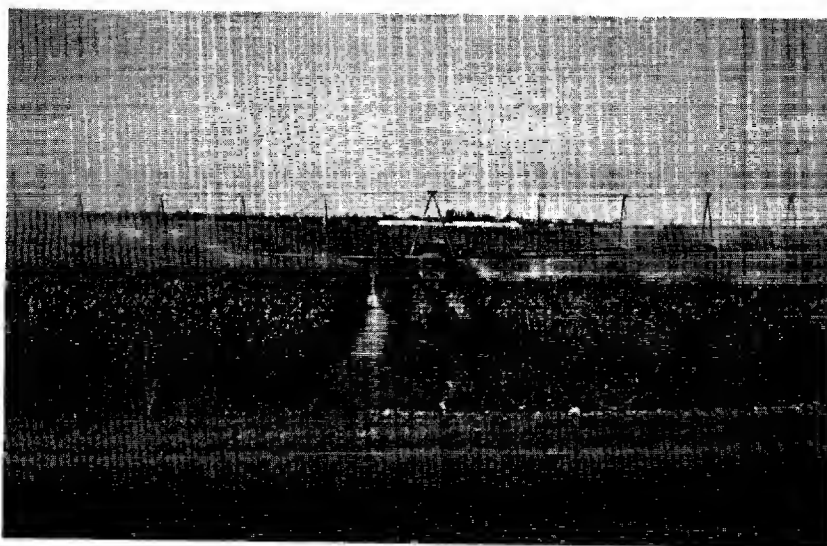


Figure 2. Mobile boom-type sprinkler irrigating sugar beets near Frunze, Kirghizia.

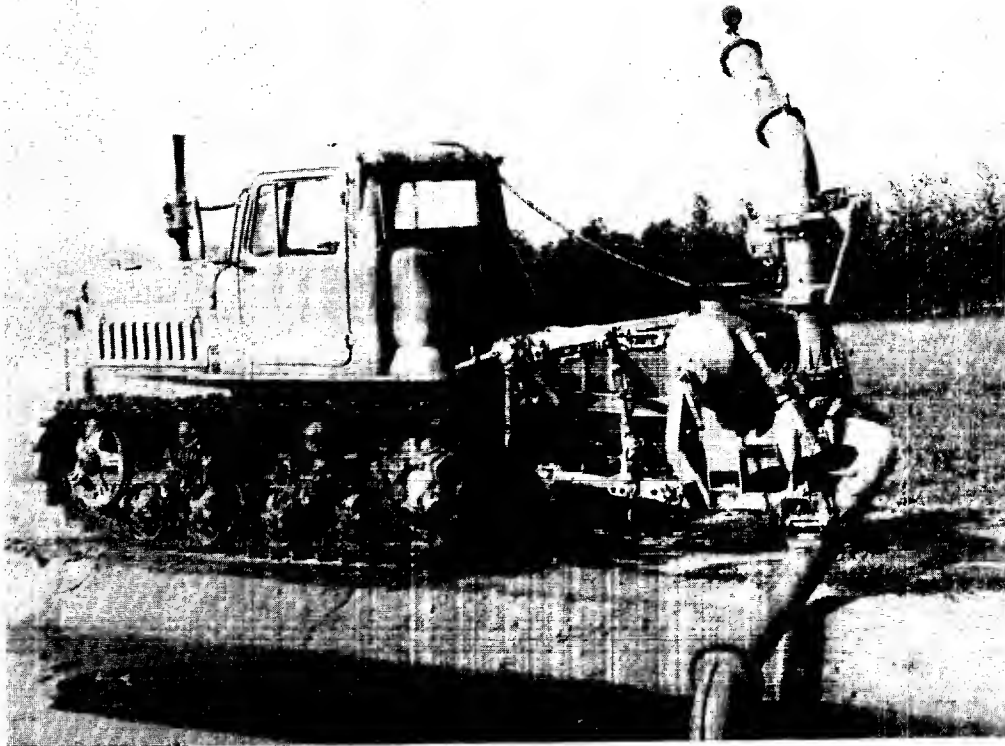


Figure 3. Big gun sprinkler.

TASHIKENT

Uzbekistan Ministry of Reclamation and Water Management

Each republic in the U.S.S.R. has a Ministry of Reclamation and Water Management. This Ministry is very important in Uzbekistan because of the eminence the Uzbek Republic holds in irrigation. Uzbekistan is the largest producer of cotton and has some of the best irrigated and irrigable lands in the Soviet Union due to its southerly location and hot summer climate. The two major river systems are the Syr Darya and the Amu Darya, both of which form in the high mountains along the southern boundary of the U.S.S.R. and empty into the Aral Sea. At the present rate of development, these river systems will soon be fully utilized. However, only approximately one-third of the potentially irrigable land is irrigated. Additional irrigation will require that more water be made available in Uzbekistan and the other republics of Central Asia. To reach the full potential for irrigation, it will be necessary to reverse the flow of several northward flowing Siberian rivers. The magnitude of these water

diversion projects is unprecedented. The successful operation of this scheme will require highly coordinated electronic supervisory control equipment and systems. Well-developed automation of water resource systems is obviously called for to meet these future requirements.

The Ministry designs, constructs, and operates the main conveyance systems of all the irrigation systems in Uzbekistan except those in the Golodnaya Steppe Project.

TASHKENT
"SANIIRI"

The Central Asia Research Institute of Irrigation, "SANIIRI," located at Tashkent has played a prominent role in the research and development of new tools for irrigation in the Soviet Union over its approximately 50 years of existence. While "SANIIRI" is a regional institute, it does some work on an All-Union (throughout the Soviet Union) basis. Eight hundred technical employees cover a wide range of activities on research and planning of all aspects of irrigation work but do not construct or operate and maintain the systems.

The institute and its associated laboratories are currently developing improved methods of irrigation automation and water measurement. Some of the work demonstrated and discussed included both hydraulic and electromechanical self-actuated automatic controls, and remote control. Some rather exotic water measurement devices were described, with emphasis on water measurement in canalettes or raised precast concrete flumes (fig. 4). In general the water measurement devices and the automation concepts developed at "SANIIRI" require a large amount of head loss for operation. However, gradients of irrigated regions in Central Asia are generally steeper than comparable ones in the United States and this would allow more head loss.

FERGHANA VALLEY

The Ferghana Valley located in eastern Uzbekistan (fig. 5) is the largest irrigated area in the Soviet Union. This tremendous agricultural area depends entirely on irrigation. The largest crop is cotton but silk from mulberry trees, corn, rice, and fruits are also produced. Irrigation has been in progress since ancient times, however, much development has taken place during the Soviet period.

The Kara Darya and Naryn Rivers flow from the high mountains in Kirghizia to the east into the Ferghana Valley and together form

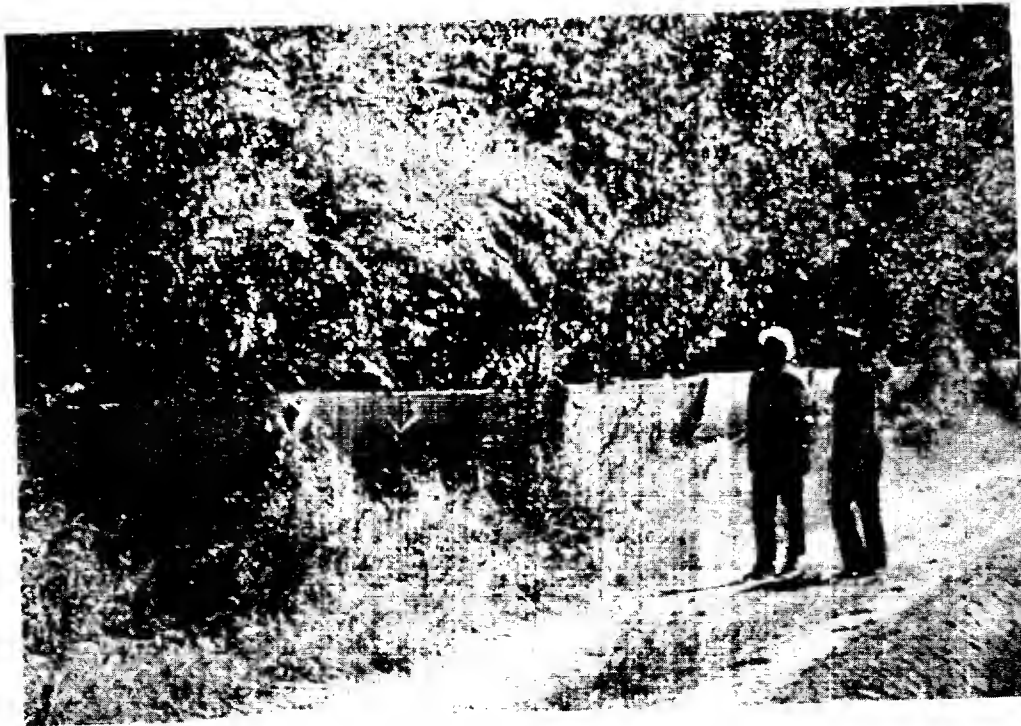


Figure 4. Canalette or above-ground reinforced concrete flume.

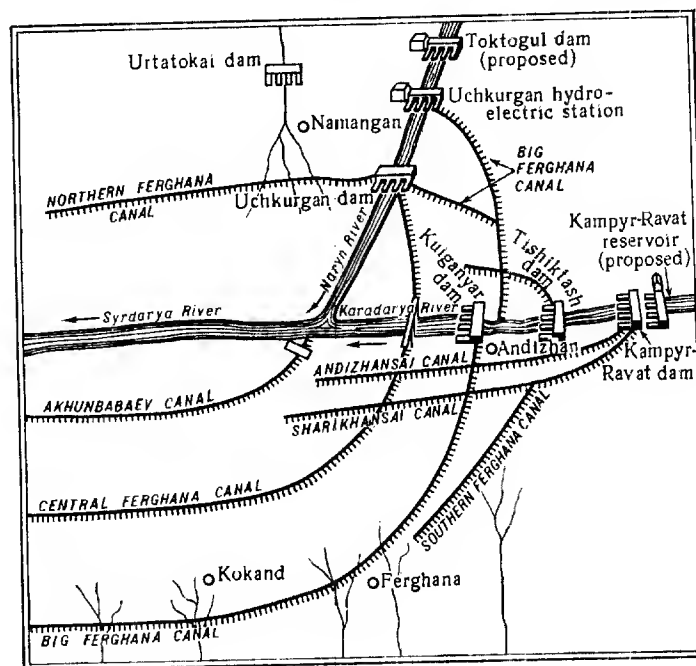


Figure 5. Layout of irrigation facilities in the Ferghana Valley. From A. N. Askochensky.

the Syr Darya which is the second largest river in Central Asia. Runoff from the Kara Darya is mostly snowmelt peaking in early summer. Runoff from the Naryn is both snowmelt and glacier melt. Thus, the Naryn has two runoff peaks - one in early summer from snow, and one in late summer from glaciers. To take advantage of this, a cross canal from the Naryn to the Kara Darya has been built above the Big Ferghana Canal. The Naryn has tremendous hydroelectric potential due to its large discharges and elevation drop. Several large dams have been built, one is under construction, and more are planned for the Naryn in Kirghizia.

Features visited included the Big Ferghana Canal headworks (fig. 6) and control center at Kuiganyar Dam and the check (fig. 7), siphon,

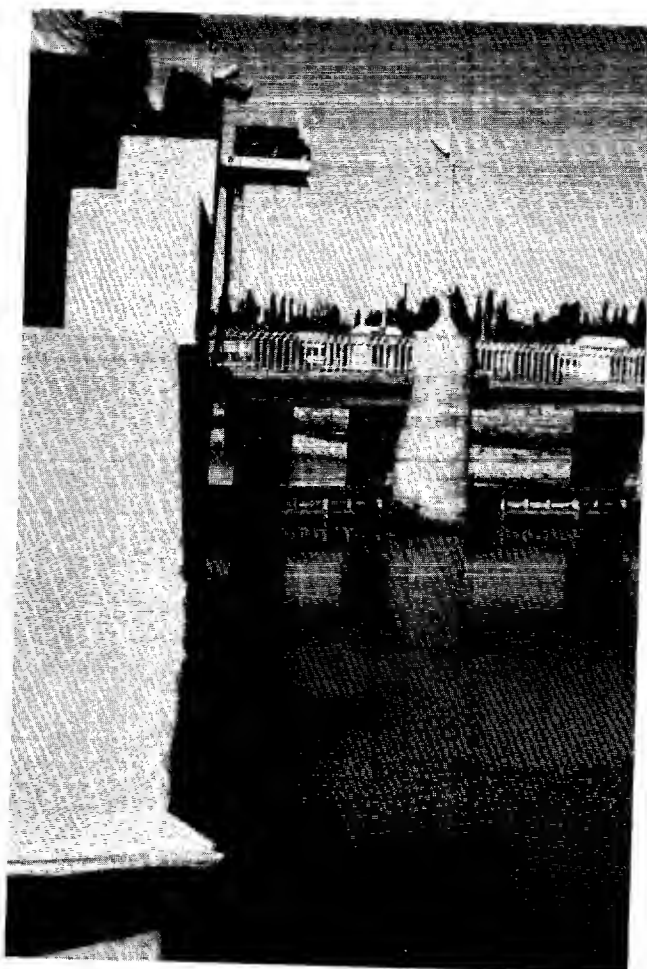


Figure 6. Ferghana Valley. Big Ferghana Canal headworks water level measurement. Note selsyn motor in top left.

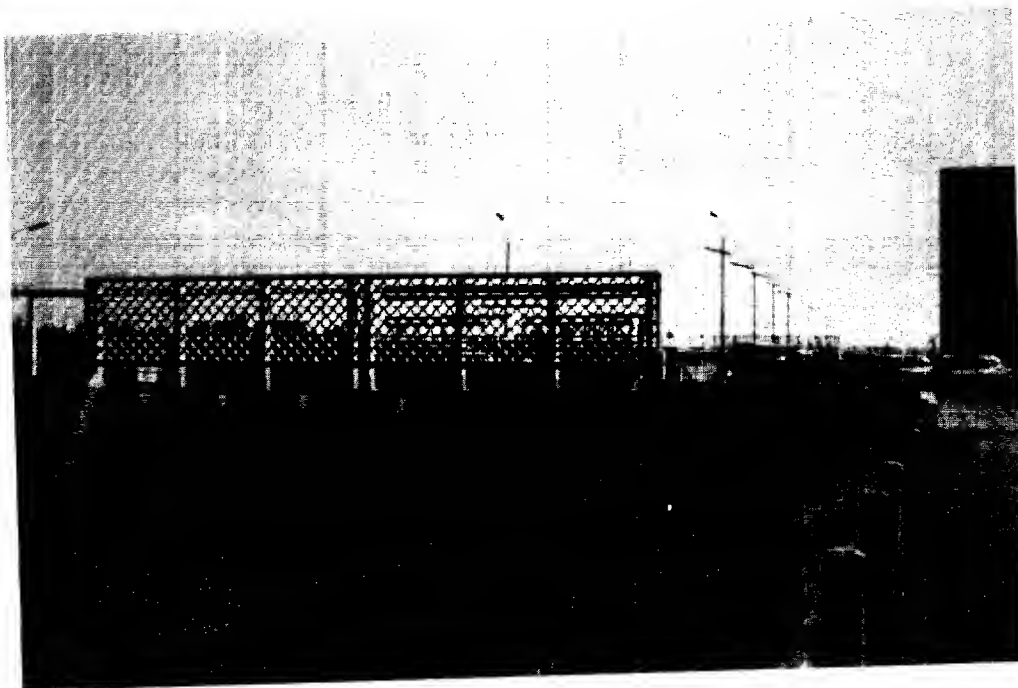


Figure 7. Ferghana Valley. Andizhan Canal check and Karadarya Siphon.

and control center of the Central Ferghana Canal at the Kara Darya River. The latter control center remotely operates canal check gates and turnout gates, while the former performs the same plus headwork gates on the diversion dam. The equipment is not sophisticated, but seems effective. Short-distance remote sensing of gate position and water level is accomplished through the use of selsyn motors while long distance requires frequency pulse or tone equipment. Push-button control is carried out by women operators. Records or data logs were kept in long hand.

GOLODNAYA STEPPE

The Golodnaya or Hungry Steppe (fig. 8) is a vast area of some 1 million hectares (2-1/2 million acres) of fertile virgin land in central Uzbekistan lying above the adjacent Syr Darya River. Limited development was started under the Czars but apparently water utilization was poor and lands became salted and lost to production. The Soviet development has progressed with emphasis on proper drainage and water use. Development work is all inclusive, starting with roads

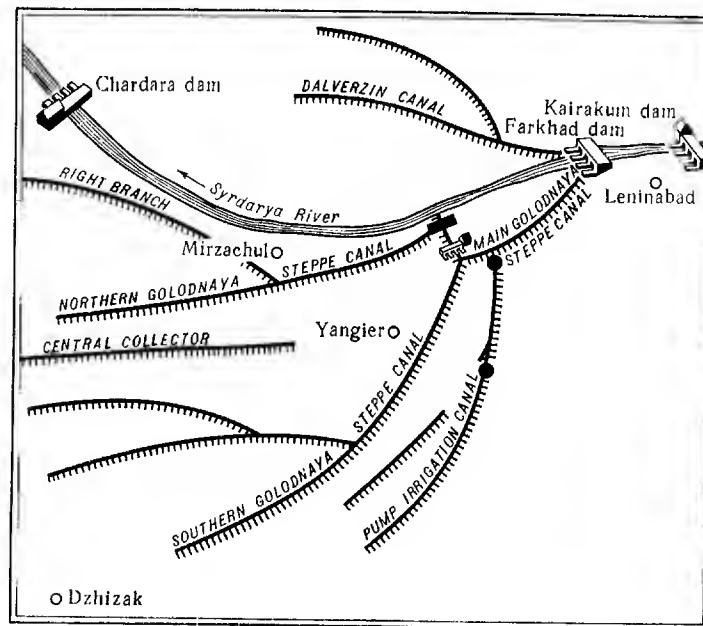


Figure 8. Layout of the Golodnaya Steppe irrigation system. From A. N. Askochensky.

and powerlines, and continuing through settlements, services, irrigation systems, and growing of crops. The construction organization will continue to build and then move to adjacent areas of the project until it is completed 10 to 20 years from now.

In the area below the Southern Canal, there will be 45 state farms of which 37 are complete. Then work will start on the north side of the canal. The construction organization maintains control until a cotton yield of 25 centners per hectare (2.2 tons per acre) is obtained. Then responsibility is transferred to the Uzbekistan Farm Ministry. This change in ministry is just at the top, since the state farm organization continues. Fourteen farms have been transferred.

The objective is to get maximum production with minimum labor. People are encouraged to move there by initial bonuses (for first 3 months given three times normal pay, rent-free housing for 2 years, etc.). About 3,000 people live on a state farm which has an area of 6,000 to 7,000 hectares (15,000-17,000 acres). The principal crop is cotton (70 percent), others include alfalfa and fruit. Over 90 percent of cotton is machine harvested (we saw some picking machines and airplanes spraying defoliates.).

Drinking water is brought in 110 km (70 miles) by pipe. The canal water is quite high in salts (1,000 ppm) and the ground water is extremely high (up to 40,000 ppm). The high salt content of the water and the need for drainage are both critical. Open drains and closed horizontal drains are provided at 3-meter (10-foot) depths, also vertical drains (pumped wells) average 18 meters (60 feet) deep.

At the 50-km (31-mile) point on the Southern Canal is a large wasteway turnout (fig. 9). The water level in the canal and the flow in

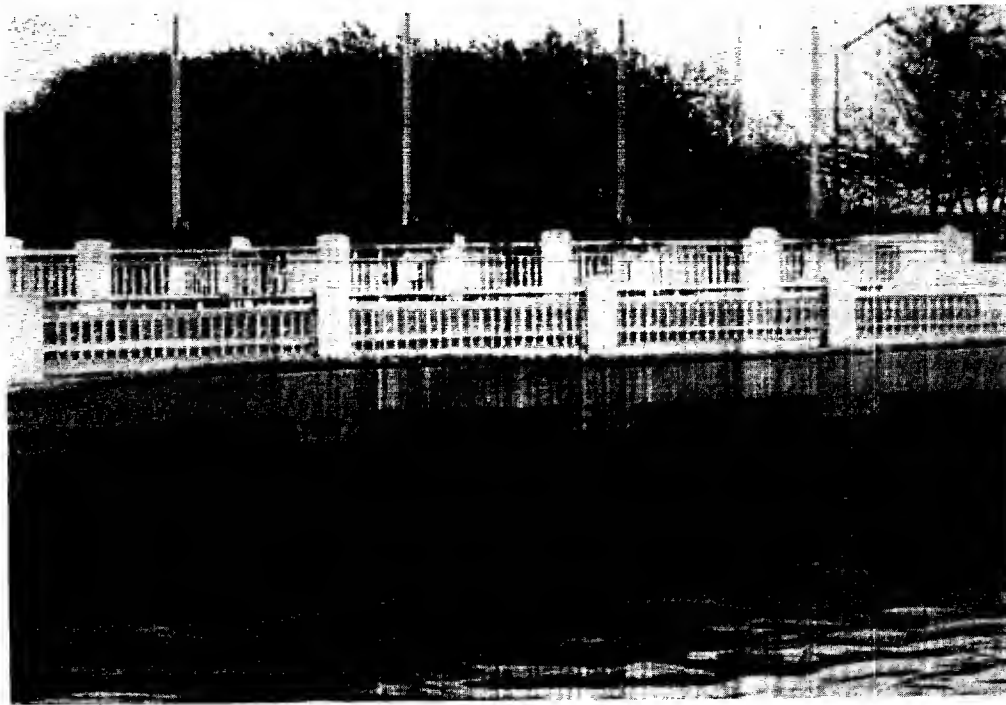


Figure 9. Wasteway turnout located at 50-km point, Southern Canal-Golodnaya Steppe.

the turnout can be regulated through remote set-point control of local automatic controllers. An automatic control (fig. 10), with sensor in the pool above the canal check, provides upstream control of the wasteway gates. Another control with sensor located below the canal check gate provides downstream control of the canal check gate. Both controls are quite similar to Reclamation's "Friant-Kern Little Man" except for the remote set-point capability.

Canalettes are widely used on the Hungry Steppe Project to distribute water from the conveyance canals to the farms.

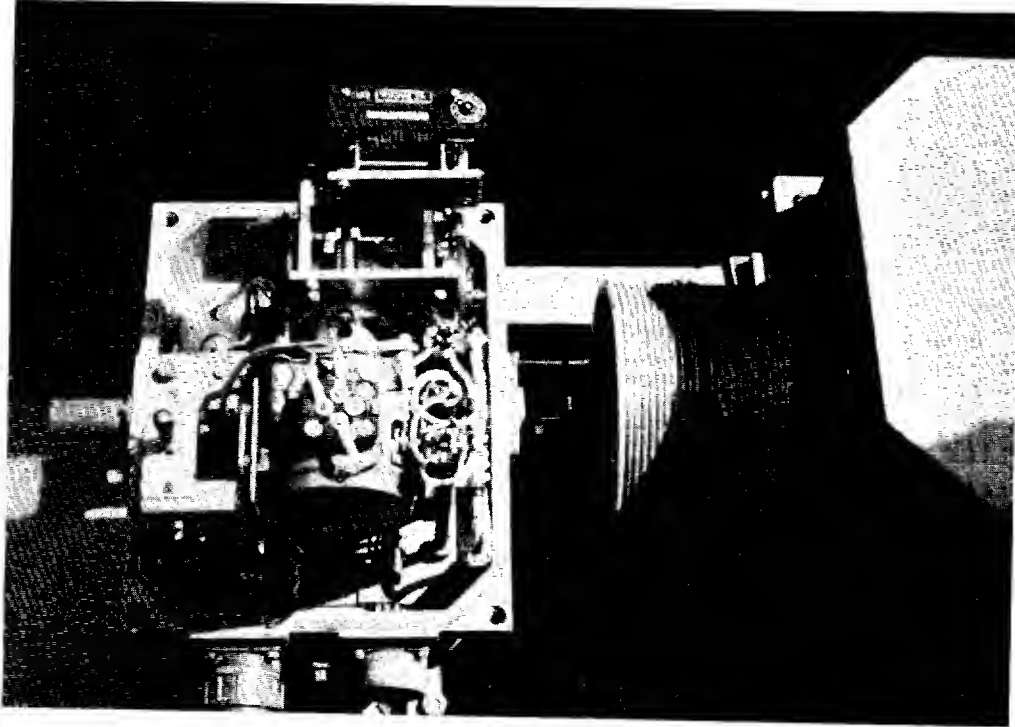


Figure 10. Golodnaya Steppe. Local water level controller which operates gates shown in figure 9.

ZARAFSHAN VALLEY

The Zarafshan Valley is located approximately in the middle of the Uzbek Republic. Climatically the Zarafshan Valley, as is all of Soviet Central Asia, is characterized by much sunlight, hot summers, great variation in daily temperatures during the year, and low precipitation. The relatively short winter is characterized by capricious weather and some years the temperature can drop to -25°C (-13°F). The irrigated zone of the eastern part of the Samarkand

Oblast is 733 to 485 meters (2,400-1,550 feet) above sea level. It is protected on three sides by comparatively high mountains and therefore the climate is somewhat milder and the precipitation greater than to the west. Cotton is raised extensively throughout the area and is the most important crop.

The Zarafshan River is the main source of irrigation water for the valley. It originates in the high mountains to the east of the valley. The runoff is derived from snowmelt peaking in June and glacier-melt peaking in August.

In the valley, the Zarafshan River is split into two branches, the Kara* Darya and the Ak Darya, which flow westwardly for 110 to 115 kilometers (approximately 70 miles) before rejoining into the Zarafshan.

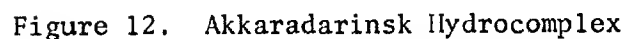
The location where the Zarafshan splits and which we visited (fig. 11) is a very important hydraulic control point. Here are



Figure 11. Akkaradarinsk Hydrocomplex. Looking downstream at the Diversion Dam.

the headworks for the Kurdanabad Canal and the Central Mainkal'ek Canal. The diversion dam and associated structures are known as the Akkaradarinsk Hydrocomplex (figs. 11 and 12).

* Note: A different Kara Darya than in the Ferghana Valley.



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In 1924 a cribwork water divider was constructed with a control structure for the Zarafshan water entering the Ak Darya and Kara Darya. This complex was somewhat improved in 1950-51 by substituting concrete for the wooden piers and downstream apron. In 1967 the construction was started on a permanent engineered hydrocomplex with the necessary canal headworks.

Construction of the Akkaradarinsk Hydrocomplex was very significant in terms of improved operations. When it became operational, water was conveyed to 85,000 hectares (210,000 acres) of Samarkand Oblast with less outlay in time and labor or regulation work. The number of takeoff points for water from the Zarafshan River was reduced from 31 to 3. All irrigation water in the Zarafshan is directed to the Kara Darya and only surplus floodwater is sent down the Ak Darya Channel. This reduces streambed losses occurring during conveyance of water in the Ak Darya. The necessity for annual performance of a large volume of protective and regulatory work on the Ak Darya is greatly reduced.

When the U.S. Delegation visited the Hydrocomplex, the remote control features (fig. 13) were explained in the adjacent control center

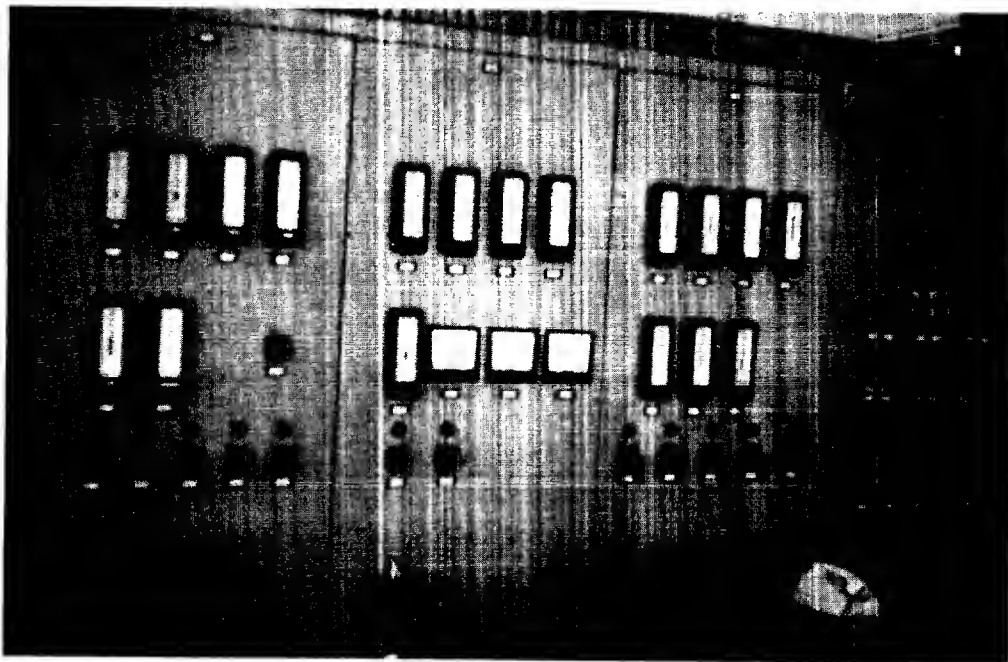


Figure 13. Near Samarkand. Akkaradarinsk Hydrocomplex remote control center.

(fig. 14). From this control center the diversion dam and canal headworks gates can be operated. Remote readout is provided for both water surface and gate position.

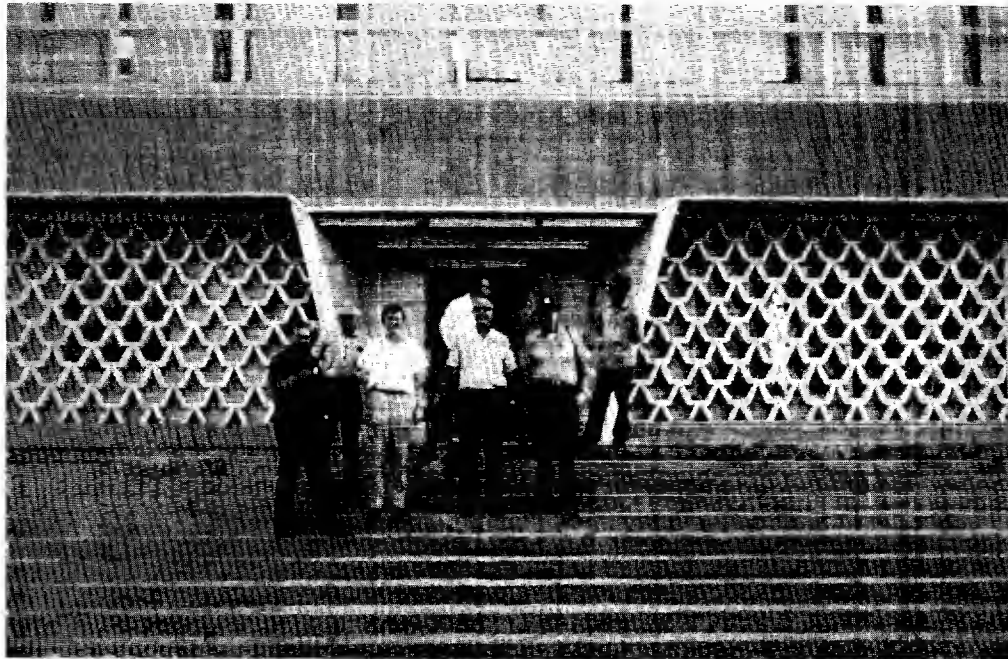


Figure 14. Near Samarkand. Akkaradarinsk Hydrocomplex office.

FRUNZE
"VNIKAMS"

"VNIKAMS" or the All-Union Scientific Research Institute of Integrated Automation of Reclamation Systems is the institute that has the responsibility of research and development for water systems automation throughout the Soviet Union. Dr. O. A. Bilik, U.S.S.R. Project Coordinator, is Director of this institute. Over 800 people are employed here. VNIKAMS is a most significant institute because of the magnitude of its responsibility and authority. Figure 15 shows the entrance to VNIKAMS Building.

Various categories of work are performed in laboratories. Groups of laboratories with common concerns are headed by divisions. There are 10 divisions in the Institute. There is also a services division which includes a computer center, chemistry laboratory, library, and training section. In addition, a total of 17 other institutes



Figure 15. VNIKAMS Office Building

throughout the Soviet Union report to this "All-Union" institute. The VNIKAMS organization chart is included in Appendix B-IV.

The array of Soviet engineering talent collected at VNIKAMS for the automation of water systems is most impressive. This highly organized and well-structured institute should produce concepts and equipment which will improve water resource development and management.

The most important business of the trip, the drafting of the Record of Meeting, Appendix A, was conducted at VNIKAMS. This agreement details the joint activities for the period 1975-76.

CHU RIVER BASIN

The Chu River originates in the mountains of Kirghizia and after leaving the mountains, flows generally northward through the Chu Valley (fig. 16) which extends into Kazakhstan. The main sources of water, in addition to the Chu itself, include its tributaries the Big Kemin, the Red, and a number of mountain streams flowing from the Kirghiz Range. The irrigated area is located in both republics and the irrigation system of the Chu Basin Directorate provides

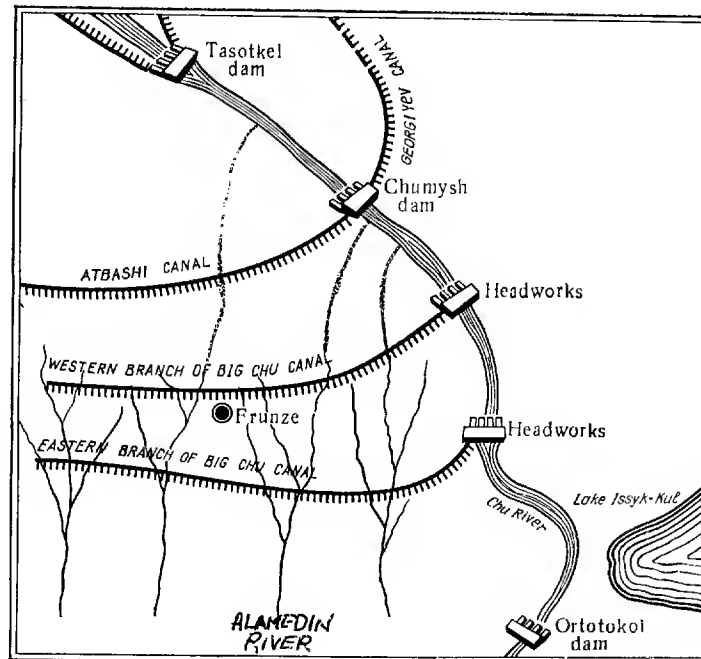


Figure 16. Irrigation Works of Chu River Basin. From A. N. Askochensky.

water to seven districts in Kirghizia and two districts in Kazakhstan. The canals also provide water for industry, power, and fisheries.

The water management system of the Chu River Basin is complex and includes Orto-Tokoisk Reservoir (fig. 17) with a capacity of 470 million cubic meters (380,000 acre feet), several large canals (fig. 18), three diversion dams (fig. 19) and numerous water distribution and control structures (fig. 20).

The canal systems are interconnected as shown in Appendix B-I. This loop arrangement provides for flexible conveyance of water with many alternatives of operation. The rivers and streams are fed both by snow and glacier melt with large fluctuations in runoff over the season. Generally the natural stream discharges do not coincide with the irrigation system demands.

A great deal of automation work has been done in several areas of the Chu Basin. The At-Bashinsk* Canal has especially been the subject of both supervisory control and local automatic control application. The water users of this canal are provided demand service when sufficient water is available. However, the users do suffer limitations during periods of water deficit.

* Same as Atbashi in figure 16.

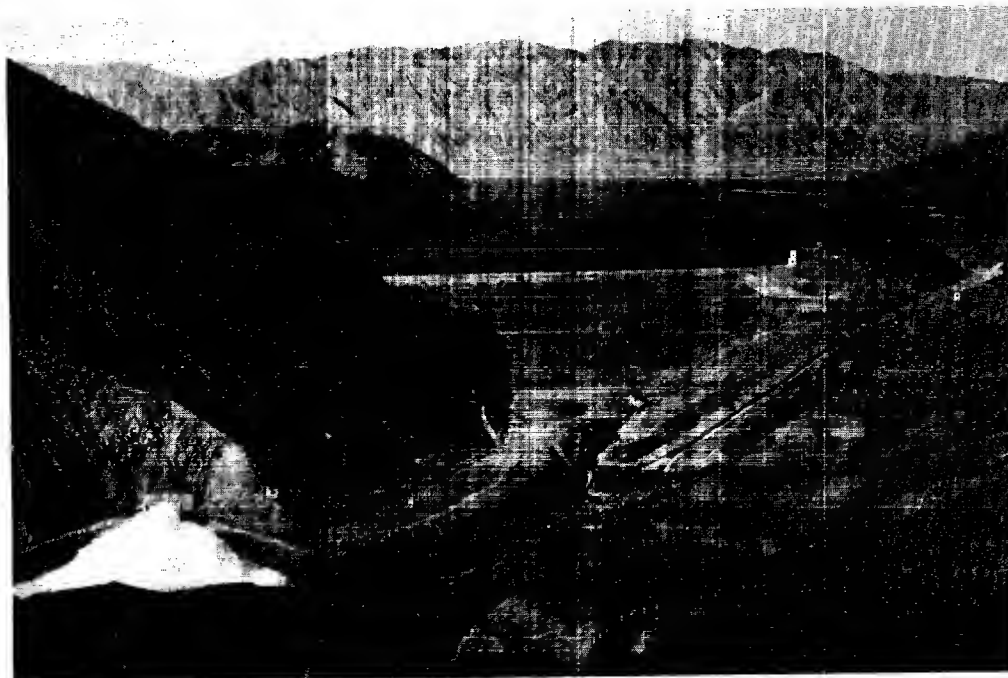


Figure 17. Orto-Tokoisk Reservoir on the Chu River. Main storage reservoir for the Chu River Basin

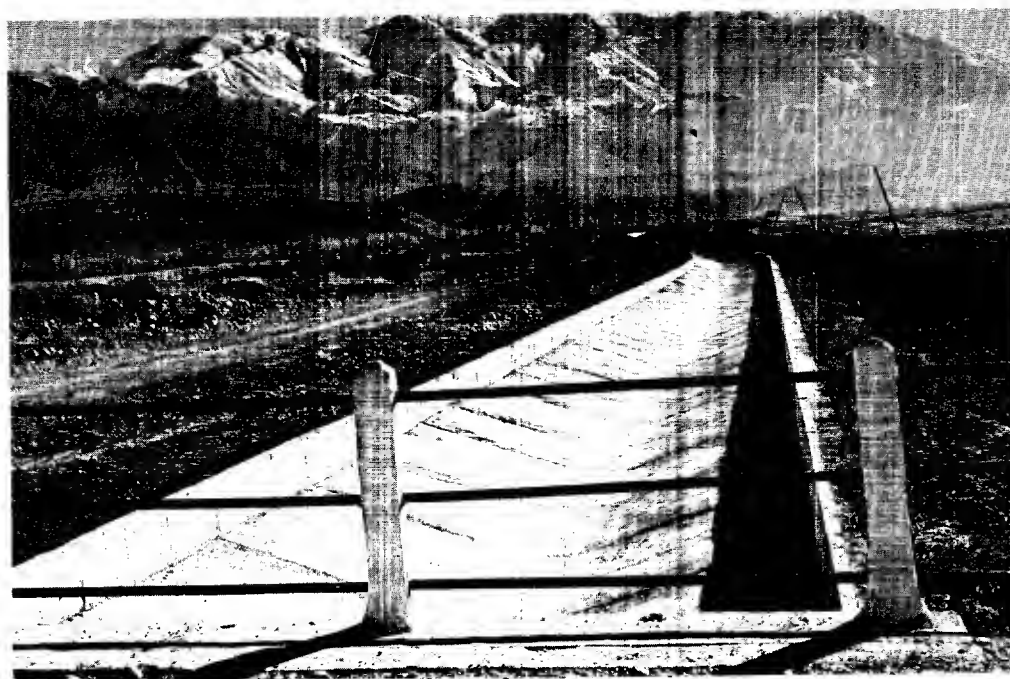


Figure 18. Typical concrete-lined lateral in the Chu River Basin

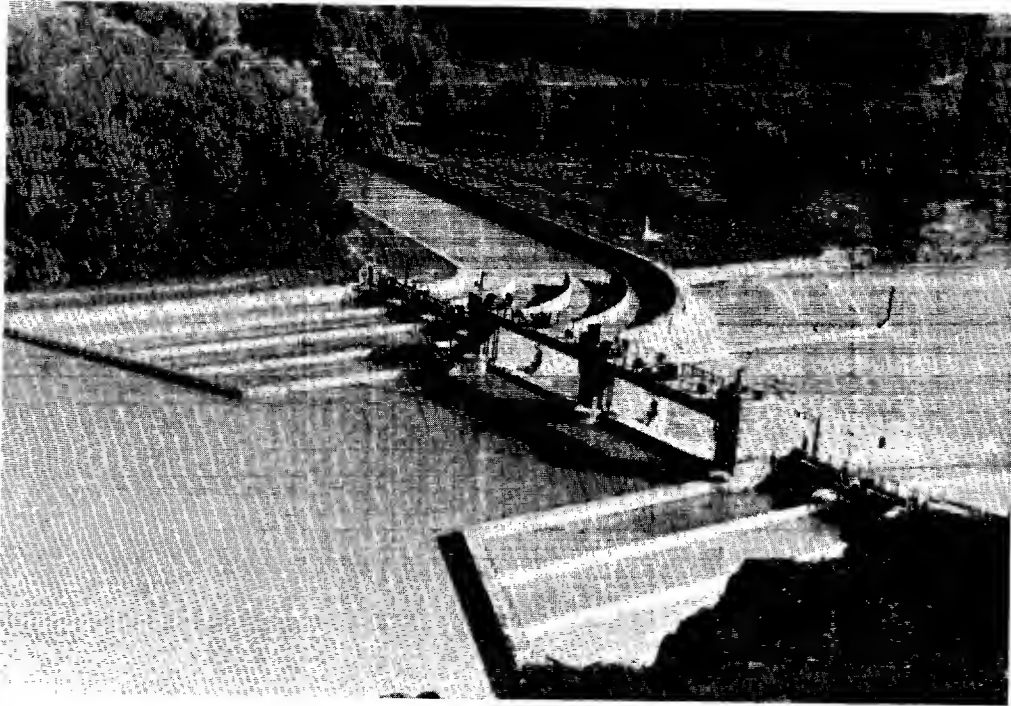


Figure 19. Chumysh Diversion Dam on the Chu River.

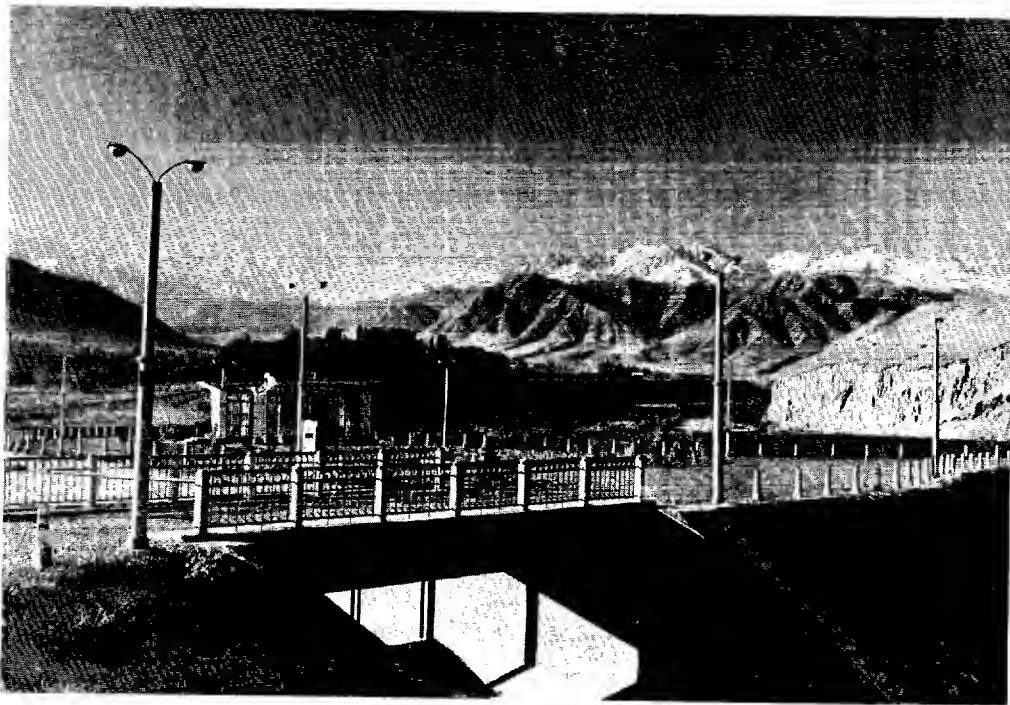


Figure 20. Alamedin River headworks to the Eastern Big Chu Canal.

Thus the Chu Basin Water System presents perhaps the ultimate challenge for optimal operation. On the supply side, regulation is provided on the Chu River but other streams discharge in a stochastic manner. The water users are allowed stochastic demand when water supplies are ample. Between the source and the users is a very complex interconnected conveyance and distribution system.

The Chu Basin was identified as the Soviet Experimental Automation Project for several reasons:

1. The system complexity described above;
2. Existing automation with experienced personnel;
3. Similarities to other areas of irrigation;
4. Feasible and successful irrigation underway; and,
5. Good location for scientific research work.

Existing automation on the At-Bashinsk Canal includes supervisory control of canal check, turnout, and wasteway gates and local automatic control of check and wasteway gates. The local automatic control is shown in Figures 21, 22 and 23.

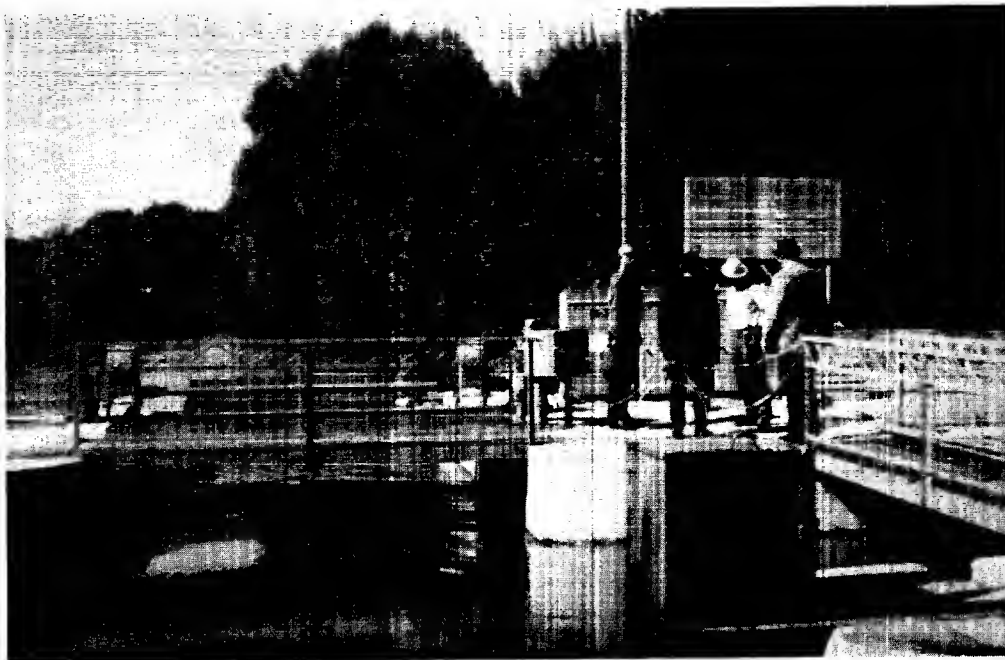


Figure 21. At-Bashinsk Canal. U.S. Delegation investigating U.S.S.R. Experimental Project

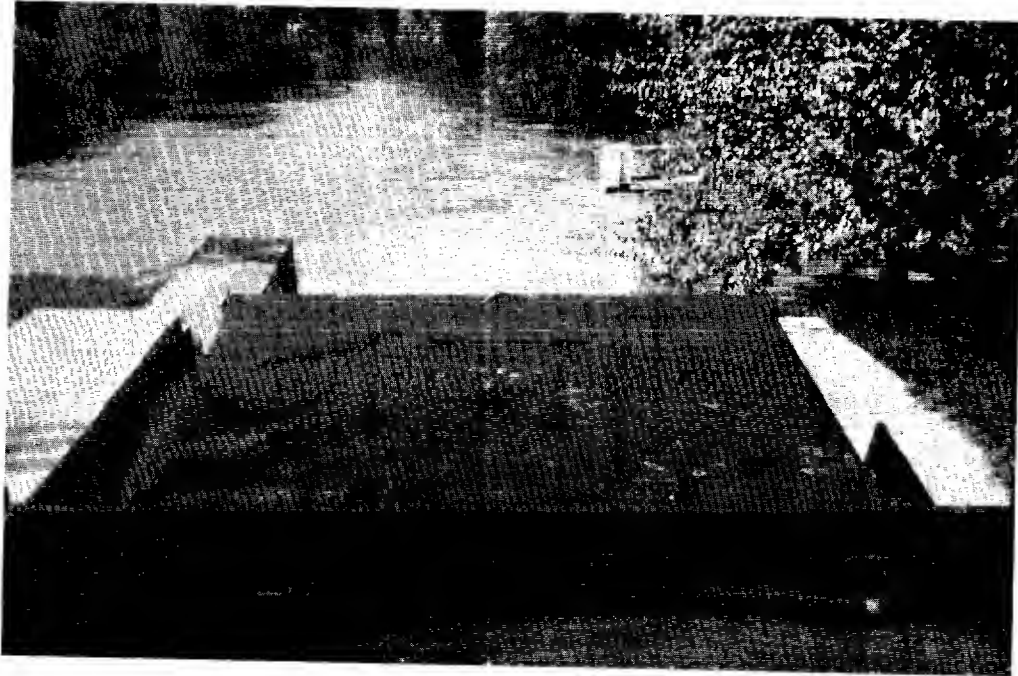


Figure 22. At-Bashinsk Canal. Note hydraulic gate with stilling well and sensor downstream on right

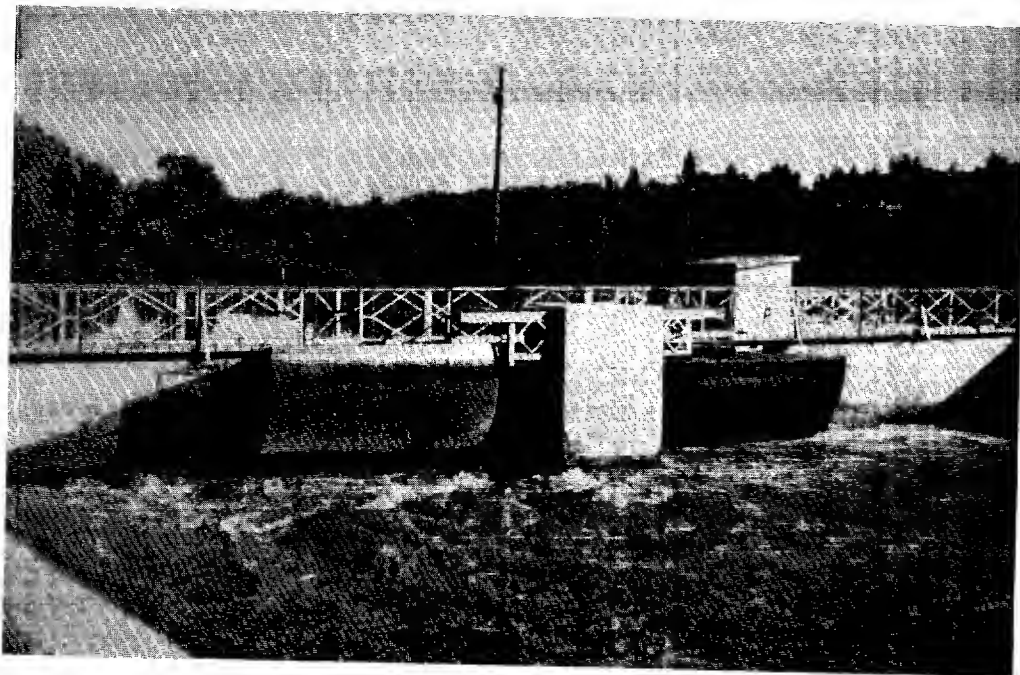


Figure 23. Near Frunze. At-Bashinsk Experimental Project Canal. Gates controlled with remote set-point hydraulic controllers.

Water from the upper reach of canal flows under or by the check gate. The discharge of water depends on the gate position. The configuration of the gate is one quarter of a cylinder with closed ends. Water enters the gate through an orifice in the upstream plate, and drains through a small valved hole in the end of the cylinder. The amount of water in the cylinder determines the weight or bouyancy of the gate and depends on the position of the valve which opens to release water or closes to hold water in the cylinder. This valve is powered either hydraulically or pneumatically by taking advantage of the differential head across the canal structure. The valve operator is connected to a float position either upstream or downstream from the canal structure. For downstream control a desired setpoint of the float is determined which corresponds to a particular water level. When the float is in this position gate action does not take place. If the water level drops, the float follows and this causes the valve in the cylinder to open thus releasing more water from the cylinder. The cylinder gate then becomes more bouyant, thereby raising and allowing additional water to be released through the canal structure. When the water level rises above the setpoint a similar reaction but opposite in effect occurs. These control devices are currently in use on the At-Bashinsk Canal. Downstream control is used on canal check structures and upstream control is used on wasteway gates. In addition, remote control of setpoint has been achieved through the use of small direct-current motors which operate from the low-voltage communications system (fig. 24). Thus conventional 110- or 220-volt electrical power systems are not required and yet precise control of canal operations is realized.

The control center for the At-Bashinsk Canal provides monitoring capabilities for water level and gate position sensors located at critical points along the canal and at the headworks, Chumysh Diversion Dam (figs. 25 and 26). At the present time a dispatcher performs this monitoring and remote control activities. The addition of a minicomputer to this operation is planned in the near future. This will allow programmable operations to be performed automatically by the computer with human interface at a higher level of decisionmaking.

Another control center visited was at the Alamedin River headworks to the Eastern Big Chu Canal (fig. 27). Here, equipment installed in 1974 allows the operators to monitor and control water levels, discharges, and gate positions at critical locations in the service area. The man in the photograph (fig. 28) is explaining how releases of water are conveyed through the network of canals to the irrigators. Water for this area can come from the east through the Eastern Big Chu Canal or can be diverted from the Alamedin River. The Alamedin River is a Chu River tributary but ordinarily the flows are fully utilized before they can reach the Chu River.



Figure 24. Controller for hydraulic gate featuring remote set-point.

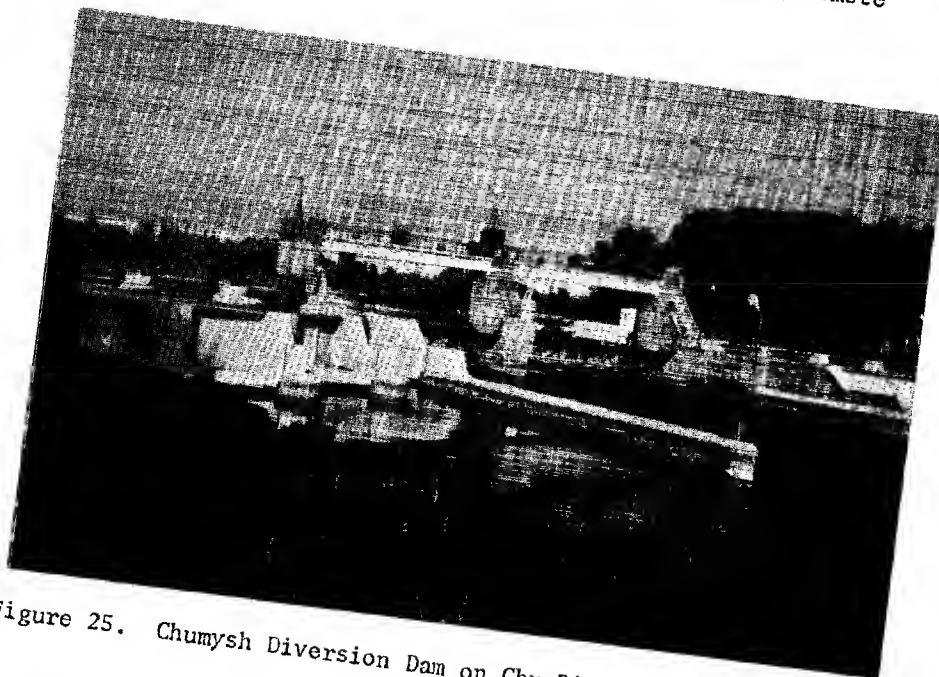


Figure 25. Chumysh Diversion Dam on Chu River.

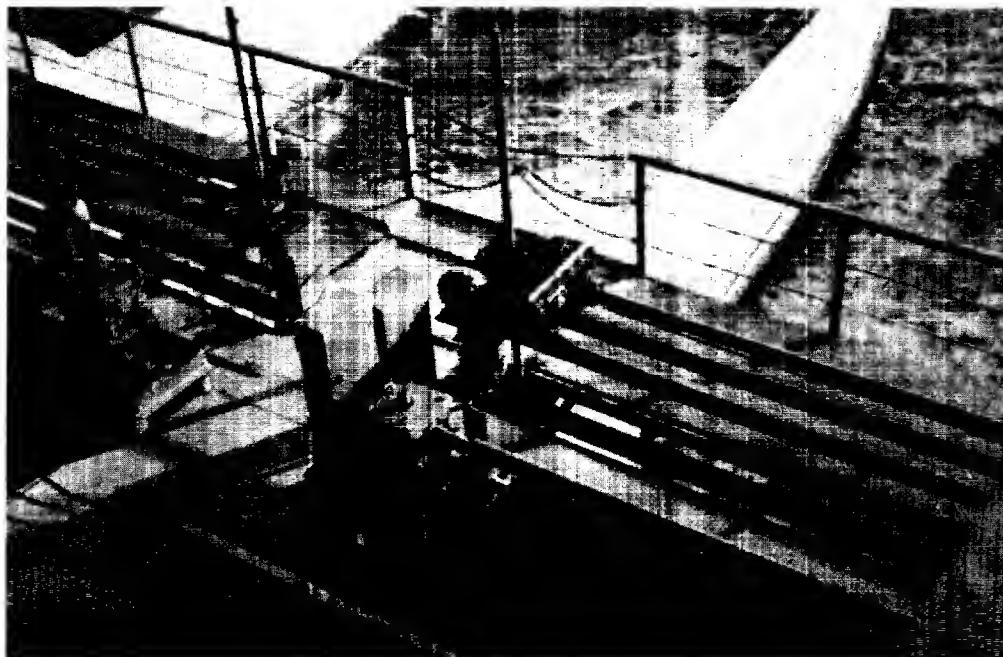


Figure 26. Motorized gates on Chumysh Diversion Dam.

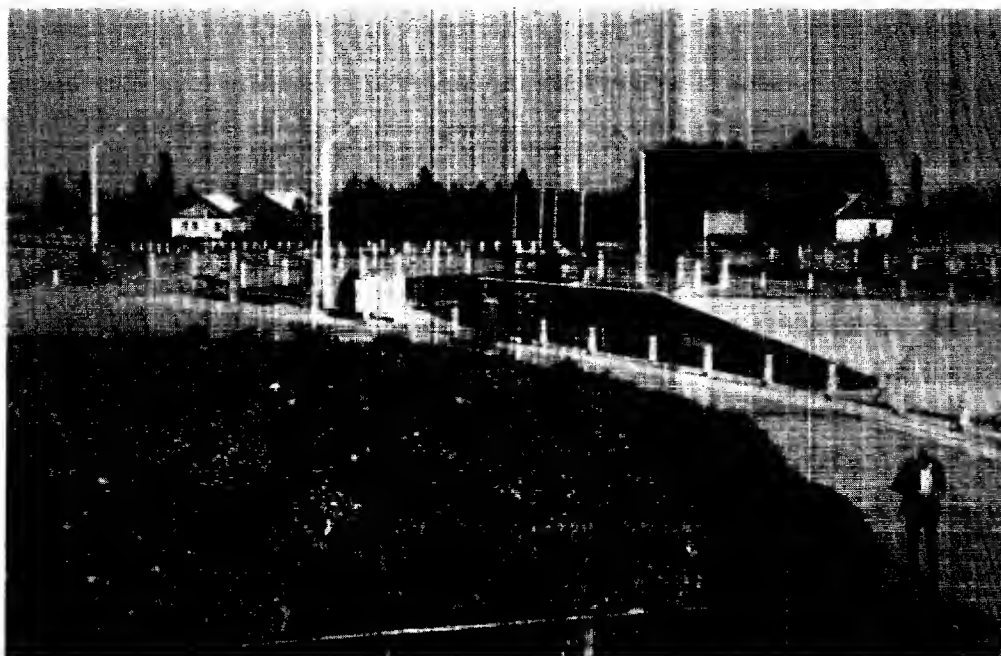


Figure 27. View of Eastern Big Chu Canal headworks



Figure 28. Chu Basin Directorate of Irrigation Systems. First Alamedinsk Branch. Diagram depicting irrigation network.

Detailed technical information on the Chu Basin is included as Appendix B.

OBSERVATIONS AND CONCLUSIONS

The importance of irrigation and the optimal development and management of water resources in the U.S.S.R. cannot be overstated. This is demonstrated by the magnitude of the Soviet effort in the subject area of automation and remote control of water resource systems. While the U.S. and the U.S.S.R. have comparable irrigated acreage at the present time it appears the Soviet potential and probable development will be greater in the future. This future development includes projects which will reverse the northward flow of several major rivers in Siberia to supply water to the thirsty South. The magnitude of the projects are unprecedented in the world. The costs will be enormous and complex control schemes will be required for successful operation.

The Soviet research and development program necessary to meet present and future needs in automation is focused through the All-Union Scientific Research Institute of Integrated Automation of Reclamation Systems "VNI IKAMS" located in Frunze. However, there are numerous other institutes throughout the Soviet Union involved in the development and application of automation to water systems.

In the Soviet Union the current level of application of automation to water systems is somewhat behind that of the United States. This is especially the case in the application of minicomputers for real-time control. There appear to be no minicomputers in this use in the U.S.S.R. at the present time. This situation will probably be remedied in the near future either through domestic production or foreign purchases of computers. The Soviets do have practical automatic and remote control equipment installed and working at many locations. Also there is a universal recognition of the system concept of water resource development and management. Unfortunately the application of systems analysis to the total water resource system from source to user appears to have some problems at the point of delivery. A similar problem is encountered in the United States with reclamation systems generally ending at the point of delivery to the farm. However, state farms or collective farms in the U.S.S.R. are usually much larger than individual farms in the United States. While much interest was expressed in on-farm automation, the United States Delegation encountered very little during the visit. Indeed, while both countries share concern about the macro water system, namely watershed, storage, and river operations at one end and onfarm, irrigation scheduling and drainage operations at the other end, automation of canal systems is emphasized in the joint program.

Current automation of canal systems in the U.S.S.R. includes the use of local electronic and hydraulic controllers installed for upstream or downstream control and the use of remote control of headworks, check, and turnout structures. Some unique equipment and concepts of operation were seen that are not in use in the United States. An example is the local hydraulic or pneumatic controller for headworks, checks or turnouts that has been widely used for some time with success. An important recent development is the ability to perform remote setpoint adjustments on this controller with only a low-voltage direct-current, single-pair communication cable.

The array of Soviet engineering talent collected for automation of water systems is most impressive. While a certain sense of concern is detected over availability of critical components, such as minicomputers, the highly organized and well-structured Soviet effort

is expected to produce concepts and equipment that will have universal application.

The joint U.S./U.S.S.R. effort in Water Resources Technical and Scientific Cooperation will produce positive results in the field of automation. The exchange of information and ideas called for in the enclosed Record of Meeting will stimulate each country to better develop their own concepts and will introduce new concepts from the other. This type of competitive cooperation brings out the best solution for common problems.

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4. "Irrigation and Water Supply in the U.S.S.R.," by A. N.
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5. "Water Problems of the Zarafshan Basin and How to Solve It,"
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Sands, 1974

APPENDIXES

Appendix A

RECORD

OF

THE SECOND US-USSR COORDINATORS MEETING ON PROJECT III 2,
"METHODS AND MEANS OF AUTOMATION AND REMOTE CONTROL IN IRRIGATION
SYSTEMS"

Frunze, Kirghiz SSR, USSR

24 September, 1975

I

In accordance with the US-USSR Agreement on Cooperation in the Field of Science and Technology, signed May 24, 1972 and the Results of Discussions of the first meeting of the US-USSR Joint Working Group on Scientific and Technical Cooperation in the field of Water Resources signed September 30, 1972, the second meeting of US-USSR coordinators was held in Frunze on September 24, 1974 on Project III 2, "Methods and Means of Automation and Remote Control in Irrigation systems".

Project coordinators, who headed the US-USSR Parties
The US Party: E.Sullivan
Assistant Commissioner-
Bureau of Reclamation

The USSR Party:
O.Bilik
Director of the All-Union Scientific Research
Institute of Integrated Automation of
Reclamation Systems

The list of participants is attached (Appendix N1).

The following items were under discussion:

1. Coordination of experimental projects for joint research
2. Consideration and approval of the Detailed Program of Works to be carried out during the second stage of cooperation for the period of 1975 and 1976.

II

1. As a result of exchange of opinions, the sides defined the general program of work for the period of cooperation (App.II). Agreement was reached on selection of the experimental project for joint research: in USSR-A Main Canal of the River Chu

Appendix A - Continued

Basin (Kirghiz SSR) in USA-a Main Canal of the Sacramento River Basin (California).

In accordance with the agreement, reached at the coordinators' meeting in USA June 1974 the USSR side has prepared technological characteristics and requirement to be met by automated control system of the selected experimental project in the USSR, and commended them to the US side. The US side will present analogous documents for experimental project in USA to the USSR coordinator before the end of the year of 1974.

They developed and adopted a fully detailed program of work of the Second phase of cooperation for 1975-1976 (Appendix 3)

2. In accordance with the coordinated program of work of the second phase the coordinators found it appropriate to carry out a mutual exchange of specialists during the fourth quarter of 1975 for mutual discussion of results of research on experimental installations relating to points 1.2.1. of the program.
3. The American Group has been acquainted with the works of some water economy organizations of USSR and visited the following organizations:

- All-Union Administration of water projects desing V/0 "Sojuzvodproject", Moscow.
- Middle Asian Research Institute of Irrigation, Tashkent.
- Uzbek SSR water projects.
- Kirghiz SSR water projects.
- Scientific Center-All-Union Scientific Research Institute of Integrated Automation of Irrigation Systems, Frunze.

4. The Project Coordinators and the participants of this Joint meeting state with satisfaction that the talks were held in an atmosphere of friendship and mutual understanding and contributed further development and extension of Cooperation in the field of Automation and Remote Control of Water Resource Systems.

The present record is signed on September 24, 1974 in two copies, Russian and English, both copies being equally valid

Mr. O.A.BILIK
PROJECT COORDINATOR
THE SOVIET PARTY

Mr. E.SULLIVAN
PROJECT COORDINATOR
THE US PARTY

E F Sullivan

Appendix A - Continued

List of Participants at Second Coordinator Meeting of US-USSR Sides on Project III "Methods and Means of Automation and Remote Control in Water Resources Systems".

US PARTY

E.F. SULLIVAN, US Project Coordinator, Assistant
Commissioner-Resource Management, Bureau of
Reclamation

CHARLES A. CALHOUN, Team Leader Water Systems Automation
Devision of Water Operation and Maintenance
Bureau of Reclamation Engineering and Research Center.
Professor P.F. FISCHBACH
University of Nebraska

LEONARD J. ERIE
Agricultural Research Service US Department of Agriculture
Water Conservation Laboratory

VLADIMIR B. GRINIOFF
Interpreter, State Department.

USSR PARTY

O.A. BILIK, Project Coordinator Director, All-Union Scientific
Research Institute of Integrated Automation of Reclamation
Systems(VNIKA Melioracii)

V.A. BESSARABOV-Deputy Director, VNIKA Melioracii,

D.A. SUIUMBAEV, Deputy Director, VNIKA Melioracii

E.E. MAKOVSKY, Department Chief, Institute of Automatics, Kirghiz SSR
Academy of Science

VLACHESLAV I. KUROTCHENKO, Chief of Technical Cybernetics
Laboratory, Institute of Automatics, Kirghiz SSR Academy of
Science.

Appendix A - Continued

Department, V/O "Sojuzvodproject".
SVETLANA F. KORBUT, secretary, Soviet side of the Joint Water Resources
Working Group, USSR Ministry for Reclamation and Water Management.

Appendix A - Continued

Program of USSR-US Working Group on Scientific and Technical
Cooperation in the Field of Water Resources
Project III-2 "Methods and Means of Automation and Remote
Control in Water Resource Systems"

!Description	!Activities at each		!Executor		!Completion		!Expected results			
	item	or phase	in the USSR	in the USA	period					
2	!	3	!	4	!	5	!	6	!	7
Design methods of automated systems to control technological processes in water projects including on-farm systems		Joint research on development and pilot operation of pre-determined experimental projects.		VNIKA reclamation; USSR Ministry of Land Reclamation and Water Management, Inst. of Automation, Kirghiz SSR Academy of Sciences		Bureau of Reclamation		1980		Automated experimental projects; recommendations on design and operation.
Analysis and selection of experimental projects		Agreement of experimental projects selected during visits of		Coordinator		Bureau of Reclamation		1974		Protocol

Appendix A - Continued

1	2	3	4	5	6	7
1.2	USRP-SS specialists in USA (June 1974) and USSK (September 1974)	Joint develop- ment of requi- rements to be met by control system, substan- tiation of assess- ment criteria, and concepts, and algo- rithms for control, information and technical behav- iors, main require- ments for program and technical facilities.	VNIKA recla- mation; Sojuz- vodproekt; Inst. of Auto- mation Kir- ghiz SSR Aca- demy of Scien- ces	Bureau of Reclamation	III quar- ter 1976	Report or scientific sub- stantiation, on technical assignment approved
1.3	Preparation of techni- cal project and drawings	Agreement and exchange of technical informa- tion	Design Institute	Bureau of Reclamation	1977	Technical project and drawings

Appendix A - Continued

1	2	3	4	5	6	7
1.4	Construction, assembly, and check-up	Activities at experimental projects and exchange of consultations	Construction and assembly organizations of USSR Ministry of Land Reclamation and Water Management	Bureau of Reclamation	1978	Acceptance Acts.
5.	Provision of tests at experimental project	Joint team	VNIKA Reclamation	Bureau of Reclamation	1979	Report on tests provision
6.	Recommendations on design and operation	Agreement and exchange of technical information	Sojuzvodproekt VNIKA Reclamation	Bureau of Reclamation	1980	Protocol on recommendations approved
	Complex of technical and program facilities for automated systems development to control technological processes in water projects, including on-farm systems	Joint research to develop and use new and existing complexes of technical and program facilities, their metrological provision and pilot operation	VNIKA Reclamation; Inst. of Automation, Kirghiz SSR Academy of Sciences; Gosstandard; Minpri-	Bureau of Reclamation	1979	Complexes of technical facilities, and recommendations on their use

Appendix A - Continued

1	2	3	4	5	6	7
2.1	Analysis of existing control and management facilities, and local automated systems as well	Exchange of technical information	VNIKA reclamation; Soyuzvodproekt; SANKIRI	Bureau of Reclamation	1975	Catalogues of control and management facilities in industries
2.2	Operation of pilot automated facilities on experimental projects, recommendations on automated facilities application and utilization.	Joint team	VNIKA reclamation	Bureau of Reclamation	1977-1978	Protocol on recommendations approved.
3	Technical facilities to provide scientific and metrological research necessary to develop automated control systems for technological processes in water projects	Exchange of information, technical materials, devices	Gosstandard, Minpribor, VNIKA reclamation	Bureau of Reclamation	1975-1976	Scientific report and data on metrological provision
4	Personnel training for developing and operating automated	Exchange of training programs, automated	Exchange of training programs, automated	Bureau of Reclamation	1976	Training program and glossary

to be executed during 1975 - 1976 between US-USSR Working Group in the Field of Water Resources on Project III 2 "Methods and Means of Automation and Remote Control in Irrigation Systems".

Description	Activities at each item or phase	Executive in the USSR	USA	Completion period	Expected results
Scientific justification and development of technical requirements for design.	Joint development of requirements for control system, basis of assessment criteria, concepts and algorithms control, information and technical schemes, main requirements for program and technical facilities.	VIIKA reclama-tion, So-juzvod-project, Institute of Automati-on, Kirghiz SSR Academy of Sciences	Bureau of Reclama-tion for all activi-ties	1976 III quarter	Report on scientific basis, record on technical assignment approved.

Appendix A - Continued

1	2	3	4	5	6	7
1.1. Research on technical and operational characteristics of experimental project.			VNIKA reclamation, USSR Ministry of Land Reclamation and Water Management.	III quarter 1975	Report on project study results.	
1.1.1. Development of methods for data collection on technical and operational characteristics of canals and main structures.			VNIKA reclamation	I quarter 1975	Methodology of collection of characteristics of canals and structures.	
1.2. Collection of technical and operational characteristics of water systems and related installations.			VNIKA reclamation, Kirghiz SSR Ministry of Land Reclamation and Water Management.	II quarter 1975	Channels and structures characteristics.	
1.3. Generalization and analysis of existing con-						

1	2	3	4	5	6	7
1.1.	Development of a water system.		VNIICA reclamation, Kirghiz SSR Ministry of Land Reclamation and Water Management.		III quarter 1975	Report on generalisation and analysis results.
2.2.	Development of assessment criteria, concepts and algorithms for control.		VNIICA reclamation, Institute of Automation		I quarter 1976	Report
2.3.	Development of informational and technical network of automated control system by technological processes on experimental projects.		VNIICA reclamation		II quarter 1976	Technical requirements for informational and technical network.
2.4.	Technical and economical basing for efficient automation of installations.		VNIICA reclamation, Sojuzvodproject		II quarter 1976	Technical and Economical justification.

Appendix A - Continued

1	2	3	4	5	6	7
1.2.5.	Development and coordination of performance specification for design of experimental project		VNIKA reclamation, V/O Sojuzvodproject.		III quarter 1976	Performance specifications approved for experimental project design.
1.3.	Development of technical project and drawings.	Agreement and exchange of technical information.	Design institute.		1977	Technical project and drawings.
2.1.	Analysis of existing control and management facilities, and local automated systems as well.	Exchange of technical information.	VNIKA reclamation, Sojuzvodproject.		IV quarter 1975	Catalogues of control and management facilities in industries.
2.1.1.	Analysis of measuring means		VNIKA reclamation, Sojuzvodproject.		III quarter 1975	Catalogue of measuring means.

Appendix A - Continued

1	2	3	4	5	6	7
2.1.2.	Analysis of control technique		VNIKA reclamation, Inst. of Automation, Kirghiz SSR Academy of Science	III quarter 1975	Catalogue of control technique.	
2.1.3.	Analysis of local automated system		VNIKA reclamation	III quarter 1975	Catalogue of local automated system.	
3.	Technical facilities to provide scientific and water measuring research necessary to develop automated control system for technological processes in water projects.	Exchange of information, technical materials, devices. VNIKA reclamation.	Gosstandard, Minpribor, VNIKA	1975-1976	Scientific reports and data on metrological provision.	

Appendix A - Continued

1	!	2	!	3	!	4	!	5	!	6	!	7
4.	Personnel training for developing and operating automated control systems for technological processes in water projects.			Exchange of training VNIKA programs, manuals, pre-reclamation of English tion, MGN, - Russian glossary. TIIMSH, Kirghiz SHI						1976		Training program and glossary approved.

Appendix B

Ministry of Reclamation and Water Management
of the U.S.S.R.

All-Union Scientific Research Institute of Complex Automation
of Irrigation Systems

SELECTION OF THE EXPERIMENTAL/OPERATING PROJECT
FOR JOINT RESEARCH ON PROJECT III.2

"METHODS AND MEANS OF AUTOMATION AND REMOTE CONTROL OF
WATER RESOURCE SYSTEMS"

O. Bilik
Coordinator of the Project
for the Soviet Team

Frunze - 1974

Appendix B - Continued

I. INTRODUCTION

With reference to the agreement between the U.S.S.R. and the U.S.A. on scientific and technical cooperation signed May 24, 1972, a program of cooperation has been worked out and agreed upon by both sides on Project III.2, "Methods and Means of Automation and Remote Control of Water Resource Systems."

The program of scientific-research work envisages the development of methods of structuring automated systems of control of technological processes in hydroreclamation systems on the basis of mutual investigations of test/experimental irrigation systems in both countries.

The ultimate goal of developing a project for mutual research is the selection, development, and experimental/operational testing of a set of technical and programming means which would assure the optimum control of technological processes in automated irrigation systems of various types. The result of the work on the experimental/operating project is the formulation of recommendations on the design and operation of similar systems.

Considering the many unusual diversified natural and structural differences of irrigation systems, the selection of such a project is recognized as being difficult if the maximum benefit is to be obtained from the work conducted on the project.

Appendix B - Continued

We selected our experimental/operating project based on the following criteria:

1. The experimental/operating project must, of necessity, have existing means of automation of the basic technological processes in reclamation and water management.
2. The basic technical and operating characteristics of the project (length of canals, bottom slope, discharges, etc.) and the operating criteria of its complexes and structures should have sufficient similarities as to zones of the countries, types, and structures of the systems.
3. The amount and stage of automation in use on the experimental/operating project should be compatible with future plans for full automation of the project.
4. The project should be located in the most typical and promising zone for irrigated farming.
5. The project should be, to a sufficient degree, ready for the introduction of an automatic control system both from the standpoint of the acute need of automation for servicing personnel and in regard to construction features.

Appendix B - Continued

6. It is desirable that the project have some experience in the use of systems and means of automation at various levels.

7. Conditions should be favorable to the conduct of scientific research work (installation and operation of apparatus, location of the project, etc.).

A detailed analysis of the characteristics of the water management complex in the Chu River Basin in Kirghisia showed that this system meets all the given criteria, and in comparison with a number of other projects, it has certain essential advantages. The information given below will serve to illustrate this.

Appendix B - Continued

II. CHARACTERISTICS OF THE WATER MANAGEMENT
COMPLEX OF THE CHU RIVER BASIN

The irrigation systems of the Chu River Basin provide water to the irrigated lands of the Chu Valley, located in an arid climate typical of Central Asian conditions (see the schematic of the irrigation systems of this basin - Appendix I). The irrigated area in the Chu Valley comprises 308,000 ha.

The water management complex of the Chu River Basin is a complicated irrigation system including a reservoir capacity of 470 million m³, main canals with a discharge of 60 m³/sec, large intake structures capable of handling 300-400 m³/sec, and a significant number of water distribution and water measuring/control structures varying in design and purpose.

The irrigation systems of the Chu Basin Directorate provide irrigation water to seven rayons 1/ of Kirghizia and two rayons of Kazakhstan. The canals also provide water for the needs of industry, power, and fish raising.

The main source of water for the Chu Basin is the Chu River itself and its tributaries, the Bol'shaya (Big) Kemin', the Krasnaya (Red), and a number of mountain streams flowing from the Kirghis Range: Kyzyl-Su, Shamsi, Issyk-Ata, Alamedin, Ala-Archa, and others.

1/ Translator's note: A rayon is the smallest administrative district making up the larger administrative unit, called an oblast.

Appendix B - Continued

The main interrayon canals basically derive their water from three sources, the Chu, the Big Kemin', and the Krasnaya. The majority of mountain streams in the basin are significant within the rayons and supply water for agricultural purposes mainly within the rayons.

The Chu River, the Big Kemin' and other mountain rivers are fed both by snows and glaciers, making for large fluctuations in runoff over the season. The discharges of these rivers over the season as a rule do not meet the hydrograph of discharges needed for the irrigation systems.

The Krasnaya River has a spring source with an insignificant variation in discharge in the course of a year (nearly 25 m³/sec).

The principal components of the water management complex of the Chu Valley are as follows:

1. The Orto-Tokoisk Reservoir, constructed on a canyon-like constriction of the Orto-Tokoisk basin of the Chu River, was designed to store water during the nongrowing period and to smooth out flood peaks in the river flow. The maximum storage capacity of the reservoir is 470 million m³. The reservoir is designed to store more than a half year's runoff of the Chu River with systematic use of all the runoff in the course of a year. It assures irrigation water to more than 220,000 ha.

Appendix B - Continued

The reservoir is formed by an earth dam 52 m high, 360 m long at the crest, and with a crest width of 60 m. It has a 570-m-long pressure tunnel with a circular section 4.5 m in diameter and a through capacity of $140 \text{ m}^3/\text{sec}$. In addition, it has an emergency spillway 700 m long, 4.0 m wide at the bottom, and slopes of 1-1/2. The maximum discharge of this spillway is $150 \text{ m}^3/\text{sec}$ (equal to the maximum discharge of the Chu River).

The Orto-Tokoisk Reservoir has a data collection system for water levels in the bowl, in the lower pool, and in observation wells. It also has a device for remote control of the discharge of the tunnel outlet.

The Chu Bypass Canal is a unique reinforced concrete water channel 16.7 km in length with a design discharge of $60.0 \text{ m}^3/\text{sec}$ and a flow velocity of 6 to 8 m/sec. The canal is rectangular in section, with a bottom width of 5.0 m, a construction height of 2.5 m, and a wall thickness at the bottom of 65 cm and 30 cm at the top.

The purpose of the canal is to increase the water reliability to a land area of 42,500 ha by avoiding a subsided zone of the Chu riverbed and reducing water losses.

The canal has four turnouts, two pipes under the canal, and eight automobile and pedestrian bridges.

The drives for the hoisting mechanisms at all the hydraulic

Appendix B - Continued

3. The Eastern Big Chu Canal passes through the eastern foothill part of the Chu Valley intersecting the alluvial fans of the mountain streams: Kyzyl-Su, Shamsi, Kegety, and others. The structure controlling water intake into the canal from the Chu River is a dam. The maximum discharge at the head of the canal is 50.0 m³/sec, the length is 97.3 km. The width of the canal bed varies from 11.0 m at the head to 4.0 m in the terminal reach. The area irrigated by the Eastern Big Chu Canal is 48,000 ha.

The canal operates solely during the growing season because it is intended for irrigation only.

The canal has 4 turnouts, 13 checks, and 5 storm drain structures.

The Eastern Big Chu Canal conveys irrigation water to the Kemin', Chu, Kant, and Alamedin Rayons; to the city of Frunze for irrigation of parks and street plantings; and it can supply water to the Western Big Chu Canal through the concrete channel of the South Distribution Canal.

In the area supplied by the Eastern Big Chu Canal, there are 30 water users, including 17 kolkhozes and 7 sovkhoses.^{2/}

^{2/} Translator's note: A kolkhoz is a collective farm composed of earlier small farms. The sovkhos is a state farm, usually organized in new farming areas.

Appendix B - Continued

4. The Western Big Chu Canal extends from east to west intersecting the central part of the Chu Valley. The canal has a dam-type headworks on the Chu River. The second source of water supply to the canal is the Krasnaya (Red) River, the flow of which is diverted to the Western Big Chu Canal by the Krasnaya River hydrocomplex.

The maximum through capacity at the head of the canal is 58 m³/sec, the length of the canal is 147 km, the bottom width of the canal varies from 20 m at the head to 10 m at the end.

The Western Big Chu Canal is an irrigation power canal. It conveys irrigation water to the Chu, Kant, Alamedin, Sokuluk, Moscow, and Kalinin Rayons, the city of Frunze, Merken Rayon of Kazakh SSR, and to the Alamedinsk Cascade of hydroelectric powerplants, the sugar and cement plants in the city of Kant, and the thermal powerplant for the city of Frunze. The area supplied by the canal has 78 users including 46 kolkhozes and 9 sovkhoses.

The reach of the canal from Pickets 3/ 468 to 500 is a temporary channel to take the flow of the Alamedin River to the Lower Ala-Archinsk Reservoir.

Beyond its upper reaches where water is conveyed for use in powerplants (as far as the Alamedin Aqueduct) the canal is used solely

3/ Translator's note: This "GK" is not the usual stationing abbreviation and a suitable interpretation cannot be found in available abbreviation dictionaries. However, the "G" could stand for hectometer, making it the same as PK, standing for canal pickets, which are a hectometer apart.

Appendix B - Continued

for irrigation and operates only during the growing period.

The total area of land irrigated by the Western Big Chu Canal is only 78,000 ha.

There are a number of complexes and structures on the Western Big Chu Canal: 105 turnouts and 78 subcanal pipes have been constructed on the canal.

5. Chumysh Dam and the At-Bashinsk Canal. - The Chumysh hydrocomplex consists of a dam-type diversion works (the dam is the El'sden type 4/) from the Chu River to the left-bank At-Bashinsk Canal in the Kirghis SSR and the right-bank Georgievsk Canal in the Kazakh SSR with a design discharge capacity of 42.5 m³/sec each. The total through capacity of the hydrocomplex is 565 m³/sec.

The At-Bashinsk Canal with a total length of 56.3 km provides conveyance of water to the Alamedin and Sokuluk Rayons for irrigating 21,200 ha of land and for power purposes (the Small At-Bashinsk Hydroelectric Powerplant). The actual discharge flowing in the canal reaches from 17 to 20 m³/sec.

The At-Bashinsk Canal has 75 hydraulic structures and 85 gaging stations. It has been partially automated: the drives for auxiliary

4/ The El'sden-type dam is defined by the Soviet Committee on Technical Terminology as "A dam-type water-intake structure with lower and sluicing galleries located in the river channel." The preferred term is frontal Approved For Release 2002/03/28 : CIA-RDP79-00798A000600100008-3

Appendix B - Continued

mechanisms in all the hydraulic structures are electrified, remote measurement of water levels has been installed at tens of gaging stations, and a number of hydraulically operated automatic controls are operating successfully.

6. The complex of features for regulating the Alamedin River runoff consists of the following structures:

- a. Sediment basin traps at water intake structures on the Alamedin River
- b. Reinforced concrete wasteway channel with a capacity of $22.0 \text{ m}^3/\text{sec}$ 10.6 km long
- c. Approach channel to the Lower Ala-Archinsk Reservoir with a conveyance capacity of $18 \text{ m}^3/\text{sec}$ and a length of 11.2 km
- d. Lower Ala-Archinsk Storage Reservoir with a capacity of 39,000,000 m^3
- e. Main canal from the reservoir with distribution canals for irrigation of 20,000 ha of land. The canal has a conveyance capacity at the head of $16.5 \text{ m}^3/\text{sec}$ and a length of 24.1 km

As an illustration of the technical equipment possessed by the irrigation systems of the Chu Basin, the technical characteristics of a few of the complexes of hydraulic structures are given in Appendix 2.

Appendix B - Continued

III. SPECIAL FEATURES OF THE OPERATION OF THE
COMPLEX OF INTERRAYON CANALS UNDER THE BASIN DIRECTORATE OF
IRRIGATION SYSTEMS OF THE CHU VALLEY

The Directorate of the Irrigation Systems of the Chu Valley exercises basin administration of the irrigation systems through its structural subdivisions (services administering the canals and complexes of large structures), through rayon directorates of the irrigation systems, and indirectly through the water users.

The administration of the irrigation systems is conducted on three hierarchical levels (Figure 1):

1. Upper - The interrepublican and interrasyon level of water division under the Basin Directorate of Irrigation Systems
2. Middle - The intrarasyon water division administered by the rayon directorates of irrigation systems
3. Lower - The intrafarm water division administered by the water users

The use of water resources of the basin is resolved taking into account of the following basic conditions.

At the beginning of the growing period (April, May) canals are supplied from the Orto-Tokoisk Reservoir because of low water in the Big Kemin' River. The water flowing along the Chu Bypass Canal goes to the Eastern Big Chu Canal from which part of the discharge is conveyed to the Western Big Chu and the At-Bashinsk Canals. In this

Appendix B - Continued

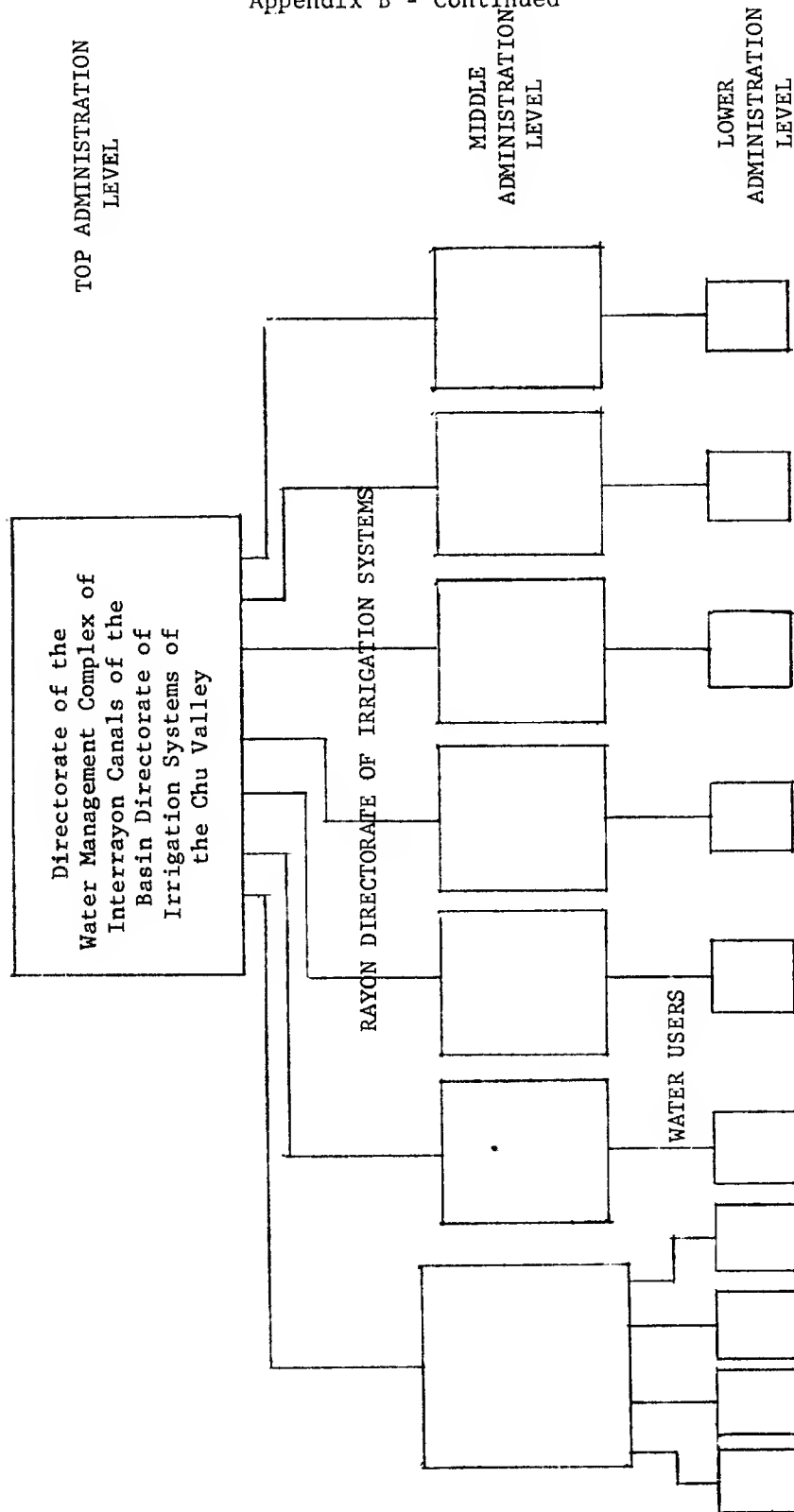


Figure 1. Hierarchical Structure of the Directorate of Irrigation Systems of the Chu Valley

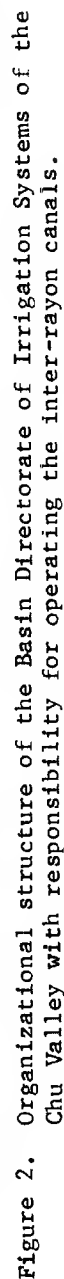
Appendix B - Continued

period the headworks structure of the Western Big Chu Canal and the Chumysh hydrocomplex discharge only return flows or seepage water in the Chu River. With an increase in discharges above the conveyance capacity of the Chu Bypass Canal, the water enters all water intake structures from the Chu riverbed.

At this point, successful operation of the systems constantly impinges on the necessity to solve a number of problems in operation planning. For example, among the goals for economic use of the water capacity of the Orto-Tokoisk Reservoir is the need for shielding the water turnout of that structure during an increase in the discharge from the Chon-Kemin' River taking into account the rapid inflow of water.

Water is discharged to the various users according to the principle of equal water reliability with full satisfaction of consumer requirements during sufficient water discharges in the system and with limitations during water deficits.

The necessary operations for intake and distribution of water are conducted by the staff at the canal operating subdivisions, which are guided in their work by the plans for water use and the instructions coming from the Central Dispatching Office (TsDP) of the Basin Directorate of Irrigation Systems (Figure 2).



Appendix B - Continued

The staff conducts the work of regulating and measuring water with transmission of all the necessary information to the Central Dispatching Office. This office compares the actual discharges with the plan (the limit) and makes a suitable decision.

The task or operation planning of water distribution is complicated by the large number of mountain streams, whose water plays such an important role in assuring irrigation water to the basin but whose discharges change appreciably.

When necessary, instructions are issued to correct the discharges in the system according to the results of an analysis of the information coming into the Central Dispatching Office.

Collection of information from the canals and transmission of orders from the Central Dispatching Office are conducted by telephone with which all large canals and structures are equipped (see Appendix 3).

The operations by direct control of the actuating mechanisms depend on the technical equipment at the structures (electric drive, means of local automation, and by hand).

Appendix B - Continued

IV. AMOUNT OF AUTOMATION FEASIBLE FOR USE
IN THE FIRST STAGE

Because of the mutual dependence of one on any of the other canals of the basin which is necessitated by the very complex scheme for intake and distribution of water as well as the numerous sources of irrigation water with very uneven runoff, the control of water distribution from the top administrative level is a very complex problem. Control of irrigation by traditional means without automated control systems cannot assure optimum water distribution without wastage of water.

Actually, good operation of the complex can be obtained only when there is the capability of timely reception of information concerning conditions at the various features and of their centralized control.

Such a task can be successfully resolved during introduction of complex automation on all levels of administration of the Chu Water Management Project. However, considering all the facts given above on the Chu Basin as a project for control, the question of automating the top level of administration in the first phase appears feasible.

Appendix B - Continued

V. PRELIMINARY REQUIREMENTS FOR AN AUTOMATED
SYSTEM OF CONTROLLING TECHNOLOGICAL PROCESSES

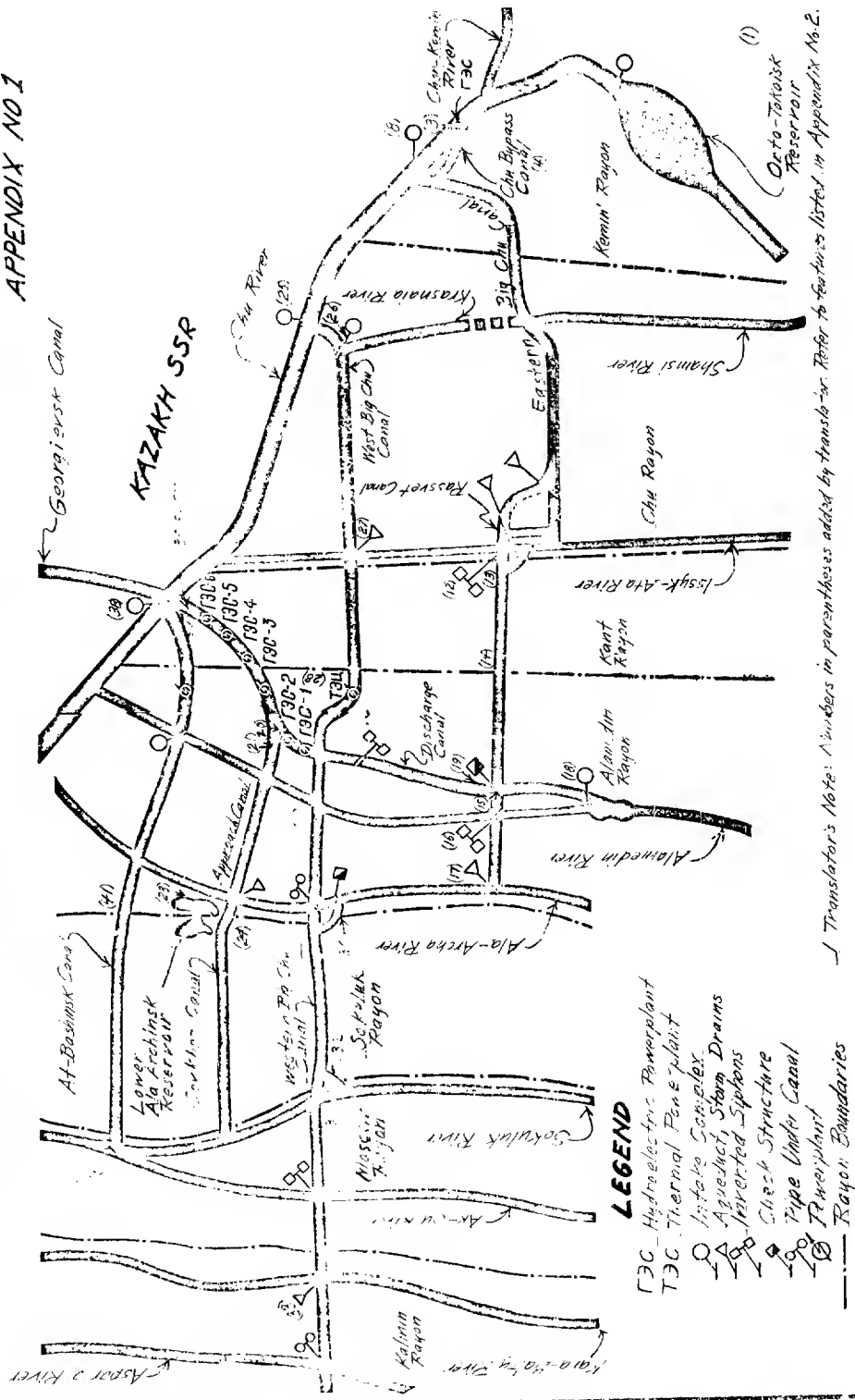
1. The system should assure the collection of information on the basic parameters of the project, characterizing its condition and enabling judgments for long-time and operating control of interrasyon water distribution (discharges of water at the head of the main canals and at alinements at the boundaries of the rayons, and others).
2. The system should have the necessary apparatus for carrying out the plans for water distribution (including the operational plans) within the time corresponding to the possibility of their effective realization in the system.
3. The system should not have to tolerate water losses in the form of useless wastage.
4. The experimental/operating project should contain subsystem prediction of runoff from the principal sources, compensating for drawdown of the Orto-Tokoisk Reservoir.
5. The experimental/operating project should have a functioning system of centralized control of the main hydraulic structures regulating the intake of water into the main canals and also at the operational boundaries of dispatching points of the second level of administration.

Appendix B - Continued

6. The subsystems of the lower levels of administration should assure fulfillment of control commands of the experimental/operating project within a time corresponding to the permissible time for realization of optimum plans for water distribution of the rayon services for control of the irrigation system.
7. The information necessary to the experimental/operating project concerning the discharges from the small sources should be gathered by the rayon control centers and transmitted to the Central Control Office.
8. The automation system for control of technological processes should envisage the use of instruments compatible with the local subsystems of the automated control system for technological processes at the lowest level.
9. The experimental/operating project should have the capability of automatic data reception with a printer as well as of signals at the project concerning deviations in control parameters from set values.
10. The apparatus should envisage the possibility of using instrumentation with automatic input and analysis of information.

Appendix B - Continued

СХЕМА ИРРИГАЦИОННОЙ СЕТИ ЧУЙСКОЙ ДОЛИНЫ
SCHEMATIC OF THE IRRIGATION NETWORK IN THE CHU VALLEY
APPENDIX NO 1



Appendix B - Continued

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TECHNICAL CHARACTERISTICS
OF SEVERAL IRRIGATION FEATURES OF THE INTERREPUBLICAN AND
INTERRAYON DIVISION OF WATER IN THE CHU RIVER BASIN 1/

Item No.	Name of feature	Picket (PK) 2/	Purpose	Availability of electrical energy	Communication equipment	Qmax m ³ /sec	Hmax u.p., m 4/	Hmax l.p., m 4/	Remarks
1	2	3	5	6	7	9	10	11	12
1.	Orto-Tokoisk Reservoir		Regulation of Chu River runoff	From power system at a voltage of 10 kW 3/	Telephone	130		1.7	
2.	Dzil'-Aryk gaging station on Chu River		Water measurement		Telephone	300			Data from Administration of Hydrometeorological Service (UGMS)
3.	Burdinsk diversion complex on Chu River		Intake for Chu Bypass Canal (CBC)	10kW TL and substation	Telephone	42.0			Difference in elevation at check structure 4.0m; at hydropl 20.0m
4.	Distribution complex of Chu Bypass Canal (CBC)	2+00	Water regulation of CBC	10kW TL and substation	-	42.0	3.1	3.1	Design Qmax = 60m ³ /sec has not been met since hydropl is not operating

1/ Translator's note: Columns 4 and 8 in Russian text have been omitted because they contained no data.

2/ Translator's note: Canals are stationed by so-called "canal pickets" (PK). The first figure represents a hectometer (100m) and the second the additional meters.

3/ Translator's note: Both the full word for voltage and the abbreviation for kW is used. The abbreviation TL will be used for transmission line.

4/ Translator's note: "u.p." and "l.p." stand for upper and lower pools, respectively.

TECHNICAL CHARACTERISTICS
OF SEVERAL IRRIGATION FEATURES OF THE INTERREPUBLICAN AND
INTERRAYON DIVISION OF WATER IN THE CHU RIVER BASIN
(CONTINUED)

Item No.	Name of feature	Picket (PK)	Purpose	Availability of electrical energy	Communication equipment	Q _{max} m ³ /sec	H _{max} u.p., m	H _{max} l.p., m	Remarks
1	2	3	5	6	7	9	10	11	12
5.	Distribution complex of Chu Bypass Canal	13+90	Water regulation of CBC	10kW TL and substation	-	42.0	2.0	1.6	Design Q _{max} = 60m ³ /sec has not been met since hydropllt is not operating
6.	Distribution complex of Chu Bypass Canal	56+50	Water regulation of CBC	10kW TL and substation	-	42.0	1.6 outlet 2.74	0.42 outlet 1.55	Design Q _{max} = 60m ³ /sec has not been met since hydropllt is not operating
7.	Distribution complex of Chu Bypass Canal	167.40	Water regulation of CBC	10kW TL and substation	-	42.0	4.00 outlet 3.0	1.6 outlet 2.8	
8.	Water intake complex in Eastern Branch of the Big Chu Canal at Chu River (EBCC)	0.00	Water intake for EBCC from Chu River	10kW TL and substation	Telephone	350	4.10 outlet 0.0	2.6 outlet 1.0	
9.	Gaging station No. 155 on EBCC	10+62	Water measurement	10kW TL and substation	Telephone	40.0	2.7	--	

Appendix B - Continued

TECHNICAL CHARACTERISTICS
OF SEVERAL IRRIGATION FEATURES OF THE INTERREPUBLICAN AND
INTERRAYON DIVISION OF WATER IN THE CHU RIVER BASIN
CONTINUED

Item No.	Name of feature	Picket (PK)	Purpose	Availability of electrical energy	Communication equipment	Qmax m ³ /sec	Hmax u.p., m	Hmax l.p., m	Remarks
1	2	3	5	6	7	9	10	11	12
10.	Kegetinsk distribution complex on EBCC	From 460+85 upstream	Water regulation for EBCC	10kW TL and substation. All gates are electrified.	Telephone	18.0	2.7	0.0	outlet -2.4
11.	Distribution complex R-12	Upstream of 460+25	Water regulation for Rassvet Canal	None	-	10.0 to Rassvet 4.0	1.2	In Rassvet 0.5	
12.	Inverted siphon under Issyk-Ata River with emergency wasteway on EBCC	680+80.6	Water regulation for EBCC	None	-	12.0	1.56	1.73	River elevations: U.P. 822.237 4/ L.P. 821.424 El. of structures: U.P. inverted siphon sill - 822.215 L.P. siphon outlet - 821.54 L.P. wasteway - 822.22
13.	Gaging station for EBCC (R-20 at Chu-Kant Rayon boundary)	691+68	Water measurement	None	Telephone	18.0	1.8	-	
14.	Gaging station for EBCC R-28 at Kant-Alamedin Rayon boundary	835+18	Water measurement	None	-	12	1.5	-	

Appendix B - Continued

TECHNICAL CHARACTERISTICS
OF SEVERAL IRRIGATION FEATURES OF THE INTERREPUBLICAN AND
INTERRAYON DIVISION OF WATER IN THE CHU RIVER BASIN
(CONTINUED)

Appendix B - Continued

Item No.	Name of feature	Picket (PK)	Purpose	Availability of electrical energy	Communication equipment	Qmax m ³ /sec	Hmax u.p., m	Hmax l.p., m	Remarks
1	2	3	5	6	7	9	10	11	12
15.	Intersection of discharge canal with EBCC (a) "Discharge" K.R. 5/ upstream of EBCC (b) "Discharge" K.R. 5/ downstream of EBCC (c) EBCC K.R. 5/ downstream of "Discharge" Canal	EBCC 916+59	Water regulation in the discharge canal and the EBCC	Electrification work in progress	Telephone	"Discharge" canal: 22.0 EBCC: 8.0	1.27	0.70	River elevations: 819.203 812.883 819.588
16.	Alamedinsk Inverted Siphon w/ wasteway to Alamedin R.	EBCC 955+49	Water regulation on Southern Distribution Canal		Telephone 4 km away	8.4	1.3 Wasteway 1.3		El of inverted siphon: 1. U.P. sill 815.26 2. L.P. outlet 815.03
17.	Wasteway structure on Southern Distribution Canal (SDC) to the Ala-Archa River	EBCC 982+92	Water regulation to SDC	None	--	8.0	1.50	0.5	
18.	Water diversion complex on Alamedin River	0+00	Water regulation in Discharge Canal	10 kW TL and substation	Telephone	75.0	In bowl of sandtrap: 4.82 Upstream of waste-way: 1.5	0.73 2.5	"Asamhai" 0.73 1.5
19.	Distribution Complex on the Discharge Canal	Discharge Canal	Water regulation in Discharge Canal	10kW TL and substation	Telephone	16.0	0.73 2.5	0.73 1.5	

5/ Translator's note: Presumably canal regulator.

Appendix B - Continued

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TECHNICAL CHARACTERISTICS
OF SEVERAL IRRIGATION FEATURES OF THE INTERREPUBLICAN AND
INTERRAYON DIVISION OF WATER IN THE CHU RIVER BASIN
(CONTINUED)

Item No.	Name of feature	Picket (PK)	Purpose	Availability of electrical energy	Communication equipment	Q _{max} m ³ /sec	H _{max} u.p., m	H _{max} l.p., m	Remarks
1	2	3	5	6	7	9	10	11	12
20.	Intersection of the Discharge Canal with the Approach Canal and Wasteway Canal from thermal powerplant	Discharge Canal: 95+93.5 96+52.8	-	None	Telephone	22.0	Wasteway: 0.7-1.7 Approach Canal drop: 1.0m	0.7-0.9	Discharge canal filled to 1.2 m
21.	Headworks structure of the Approach Canal	0+00	Water regulation in Lower Ala-Archinsk Res.	Electrification by direct current	-	18.0	2.7	0.0	
22.	Gaging station on the Approach Canal		Water measurement	Electrification by direct current	-	16.0	1.8	-	
23.	Lower Ala-Archinsk Reservoir	Along the Approach Canal below 113+00	Storage of Alamedin R. runoff	10-kW TL and substation	Telephone	16.0	10.5	-	
24.	Gaging station on the Main Canal (Alamedin-Sokuluk Rayon boundary)	Main Canal 78+50	Water measurement	None	---	10.0	1.8 0.8	1.5	
25.	Water diversion complex for the Western Branch of the BCC (WBCC)	0+00	Water intake for WBCC	10-kW TL with substation	Telephone	Chu R. 350 WBCC: 45.0	4.1 outlet: 2.6	outlet: 1.5	

Appendix B - Continued

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TECHNICAL CHARACTERISTICS
OF SEVERAL IRRIGATION FEATURES OF THE INTERREPUBLICAN AND
INTERRAYON DIVISION OF WATER IN THE CHU RIVER BASIN
(CONTINUED)

Item No.	Name of feature	Picket (PK)	Purpose	Availability of electrical energy	Communication equipment	Q _{max} m ³ /sec	H _{max} u.p., m	H _{max} l.p., m	Remarks
1	2	3	5	6	7	9	10	11	12
26.	Krasnaya River distribution complex on the WBCC	21.92	Water regulation in the WBCC	10kW TL and substation	Telephone	WBCC: 59 Krasnyi Main Canal: 12 Wasteway to the Krasnaya R: 29 100.0	2.5 Wasteway 2.9	2.3	
27.	Issyk Atinsk aqueduct with wasteway to the Issyk-Ata River	256+69	Water regulation in WBCC	None	Telephone	56.0 Wasteway 47.0	4.10 Wasteway 3.10	3.50 Wasteway 1.8 Drop: 8.0m	
28.	Lebedinsk Hydroppit	WBCC 446+00		Electrified	Telephone	40.0	3.5	0.0	
29.	Alamedinsk aqueduct with wasteway to Alamedin River	WBCC 446+00	Water regulation in WBCC	Electrified from L. 1/ Hydroppit No. 1	--	50.0 Wasteway 56.0	3.10 Wasteway 3.10	0.0 Wasteway 2.52	
30.	Control structure on the supply channel from the Ala-Archa R. to the WBCC	WBCC 571+99	Water regulation in the supply channel	None	--	8.0	2.10 0.9	0.0 0.6	

1/ Translator's note: Except for the singular used in (27) and the name "Alamedinsk Cascade" used in the text for the 6 powerplants on the Lower Alamedin River, this "L" would appear to stand for Lebedinsk Powerplant No. 1. If so, why was not the same source of power indicated in (28) and Alamedinsk Cascade as used in (35)?

Appendix B - Continued

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TECHNICAL CHARACTERISTICS
OF SEVERAL IRRIGATION FEATURES OF THE INTERREPUBLICAN AND
INTERRAYON DIVISION OF WATER IN THE CHU RIVER BASIN 1/
CONTINUED

Item No.	Name of feature	Picket (PK) 2/	Purpose	Availability of electrical energy	Communication equipment	Qmax m ³ /sec	Hmax u.p., m	Hmax l.p., m	Remarks
1	2	3	5	6	7	9	10	11	12
31.	Sokuluk inverted siphon with wasteway to Sokuluk River	WBCC 823+60	Water regulation in WBCC	Electrified at 4 kW	---	42.0	2.6 Wasteway	2.3 Wasteway	
32.	Supply from Sokuluk River	WBCC 823+60	Water intake for WBCC upstream of Sokuluk R.	None	---	15.0	1.0	-	
33.	Karabaltinsk aqueduct with wasteway to Kara-Balty R.	WBCC 1146+00	Water regulation for WBCC	None	Telephone	22.0 Wasteway 16.	2.4	0.0	
34.	Gaging station on WBCC (R-27) at the boundary with Merken Rayon of KazSSR	WBCC 1425+25	Water measurement	None	---	10.0	2.2	1.1	
35.	BSR 1/ upstream of Chumysh Hydrocomplex		Regulation of discharge in tailrace of Alamedinsk Hydroplants	None	---	50.0	2.6	--	
36.	Automatic regulator at the BSR		Regulation of discharge in tailrace of Alamedinsk Hydroplants	None	---	15.0	2.6	--	

1/ Translator's note: Aerospace's glossary of Russian abbreviations gives "overflow signaling device" for BSR.

Appendix B - Continued

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TECHNICAL CHARACTERISTICS
OF SEVERAL IRRIGATION FEATURES OF THE INTERREPUBLICAN AND
INTERRAYON DIVISION OF WATER IN THE CHU RIVER BASIN
CONTINUED

Item No.	Name of feature	Picket (PK) 2/	Purpose	Availability of electrical energy	Communication equipment	Q _{max} m ³ /sec	H _{max} up, m	H _{max} lp, m	Remarks
1	2	3	5	6	7	9	10	11	12
37.	Gaging station on the tailrace of the Alamedinsk Hydroplit cascade	1+02 from structure	Water measurement	None	---	50.0	4.0	2.0	
38.	Chumysh Hydrocomplex on Chu River	0+00	Water intake for the At-Bashinsk Main Canal	6-kW TL and substation	Telephone	300.0	4.0	-	
39.	Headworks structure for At-Bashinsk Main Canal on Alamedin River with waste-way	0+00	Water regulation for At-Bashinsk Main Canal	6-kW TL and substation	Telephone	102.0 Regulator 32.0	3.0	No data	
40.	Emergency spillway on At-Bashinsk Main Canal	320+24		0.40 kW TL	Telephone	4.5	2.0 Wasteway 2.0	2.0	
41.	Gaging station and check structure (Skuluk and Alamedin Rayon boundary)	Downstream of R-6: 144+00	Water regulation and measurement	None	Telephone	20.0	1.5 2.2	1.5 1.75	
42.	Terminal Wasteway for At-Bashinsk Canal	432+15		0.4-kW TL	Telephone	4.0	1.5	0	

1/ Translator's note: Aerospace's glossary of Russian abbreviations gives "overflow signaling device" for BSR.

SINGLE-LINE COMMUNICATIONS SCHEMATIC
Basin Directorate of Irrigation Systems of the Chu Valley

ПРЯМОЛИНЕЙНАЯ СХЕМА

СХЕМА БАССЕЙНОВОГО УПРАВЛЕНИЯ ПРОСТРАНСТВЕННЫХ СИСТЕМ ЧУЙСКОГО АТОМЫ

APPENDIX III

The diagram illustrates the communication infrastructure for the Basin Directorate of Irrigation Systems of the Gila Valley. It features three main canals: the AT-Bashinsk Canal, the Central Canal, and the Western Canal. Various communication lines, including telephone and telegraph lines, are shown connecting different points along these canals. Key structures and equipment are labeled, such as the 'Soviet Union' building, 'Central Canal' building, and 'Western Canal' building. The diagram also shows the 'Basin Directorate of Irrigation Systems' and the 'Gila Valley' area. A legend at the bottom right explains the symbols used for different types of communication lines and structures.

Legend	Source	Possible Translation
AT-B	AT-Bashinsk	AT-Bashinsk
AT-C	AT-Central	AT-Central
AT-W	AT-Western	AT-Western
AT-L	AT-Lake	AT-Lake
AT-R	AT-River	AT-River
AT-S	AT-Sea	AT-Sea
AT-A	AT-Air	AT-Air
AT-G	AT-Ground	AT-Ground
AT-U	AT-Underground	AT-Underground
AT-O	AT-Overhead	AT-Overhead
AT-D	AT-Direct	AT-Direct
AT-I	AT-Indirect	AT-Indirect
AT-M	AT-Medium	AT-Medium
AT-H	AT-High	AT-High
AT-L	AT-Low	AT-Low
AT-M	AT-Medium	AT-Medium
AT-H	AT-High	AT-High
AT-L	AT-Low	AT-Low

TABLE (Continued)

Legend

Source

Possible Translation

AT-Bashinsk

AT-Central

AT-Western

AT-Lake

AT-River

AT-Sea

AT-Air

AT-Ground

AT-Underground

AT-Overhead

AT-Direct

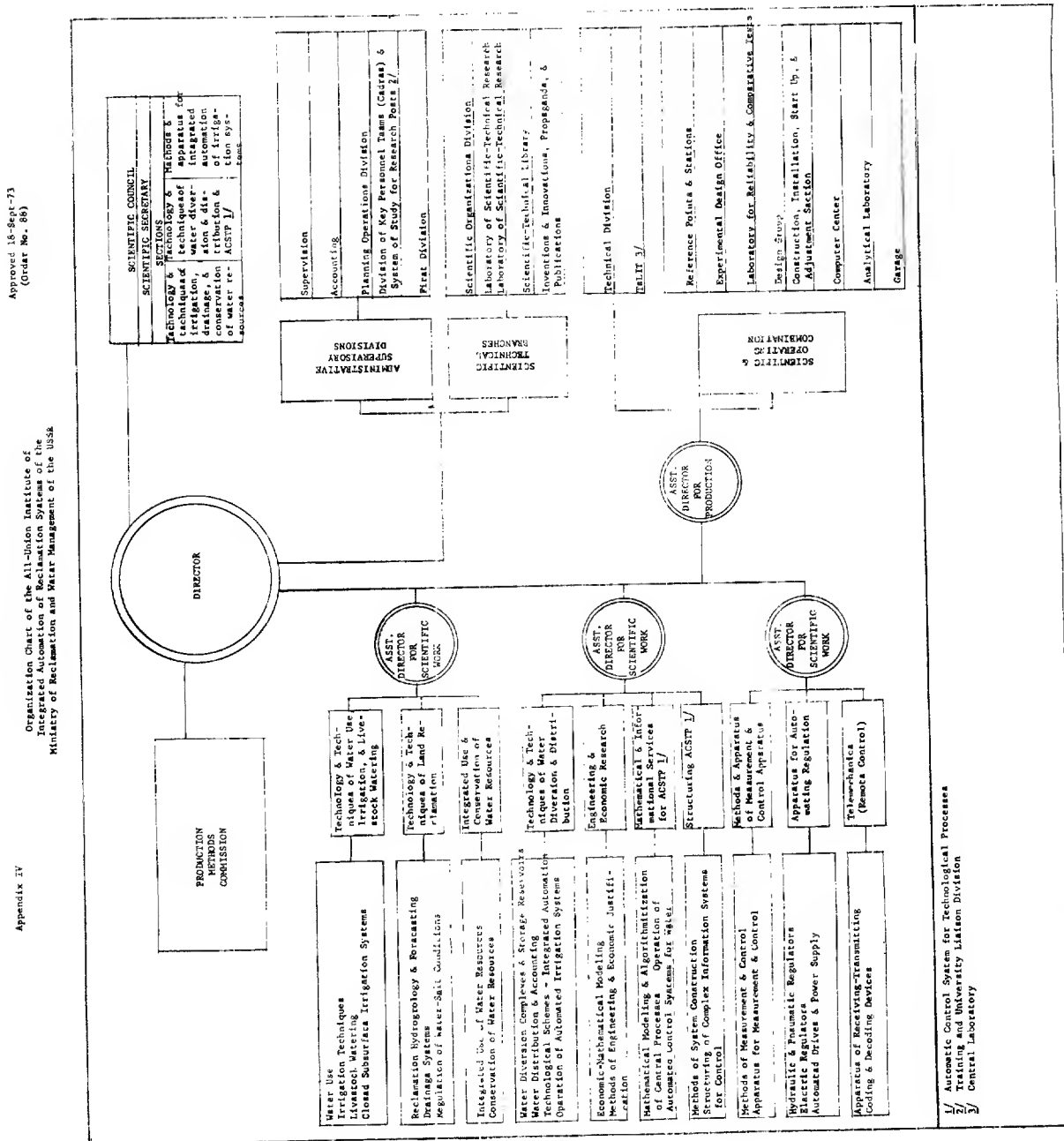
AT-Indirect

AT-Medium

AT-High

AT-Low

Appendix B - Continued



Appendix C

DELEGATION MEMBERSHIP AND SOVIET HOSTS

Travel to U.S.S.R.
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"Methods and Means of Automation and Remote
Control of Water Resource Systems"

U.S. Delegation

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Appendix C - Continued

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